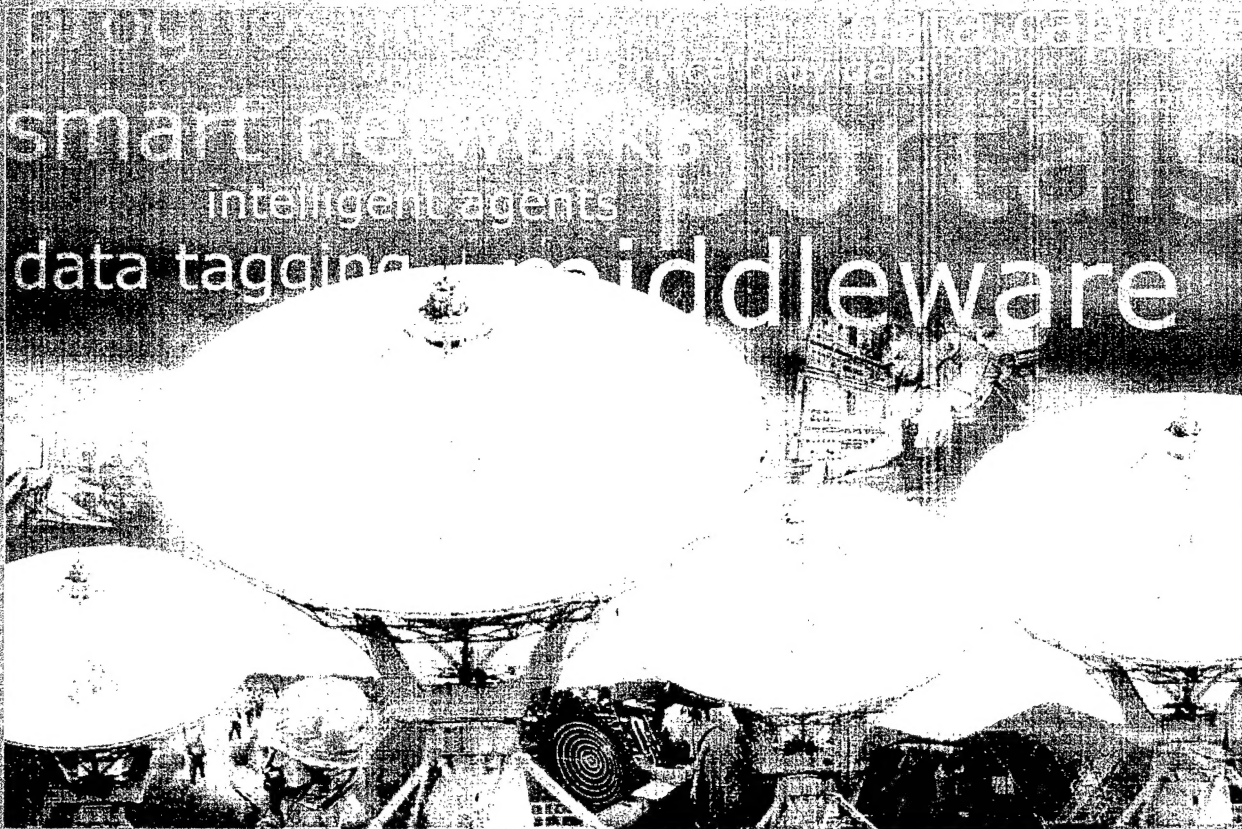


Logistics Technology 2010 Implications for DoD

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Logistics Technology 2010

Implications for DoD

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December 2000

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Logistics Technology 2010:
Implications for DoD

LG904T1/DECEMBER 2000

EXECUTIVE SUMMARY

Logistics Management Institute (LMI) assessed the impact of new and emerging technologies on the future architecture of DoD logistics. This assessment supports the primary objective of the Assistant Deputy Under Secretary of Defense (Logistics Architecture) (ADUSD[LA]) to design and coordinate implementation of a logistics architecture that inherently meets Joint Vision 2010 requirements.

To determine potential areas of opportunity for the Department, LMI assessed the degree of alignment between

- ◆ the University of Maryland's exploratory technology forecast recommendations for the Department,¹
- ◆ the technology implications of guiding documents for DoD logistics, and
- ◆ technologies supported by initiatives reported to the Office of the Secretary of Defense and Congress in official submissions.

The University of Maryland exploratory forecast used the year 2010 as a target and identified trends and supporting technologies that would then be available. LMI used these four trends as the baseline for future technology opportunities:

- ◆ *Connectivity and bandwidth.* Accelerating connectivity and increased bandwidth through the use of high-speed cable and broadband satellites and antennae
- ◆ *Smart networks.* Increased use of smart networks enabled by high-speed routers, switches and chips, artificial intelligence, common protocols and application service providers (ASPs)
- ◆ *Real-time total asset visibility.* Real-time total asset visibility facilitated by advanced data tagging and capture equipment and real-time prognostic and diagnostic systems

¹ Sandor Boyson and Thomas Corsi, *The Year 2010 Netcentric Supply Chain: An Exploratory Technology Forecast*, University of Maryland, May 2000.

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- ◆ *Fully integrated supply chains.* More integrated supply chains that use intelligent agents, portals, middleware and automated messaging systems.

Although technology does not appear to be the centerpiece of most current logistics efforts, DoD's logistics initiatives generally appear to be enabled by the technologies of the exploratory technology forecast.

- ◆ There appears to be greater overall emphasis on fully integrated supply chain management than on connectivity and bandwidth, smart networks, and real-time asset visibility.
- ◆ True technology gaps appear to exist for common protocols, diagnostics and prognostics, the use of ASPs, and supplier portals.
- ◆ Although the absence of common protocols represents a significant issue within DoD, middleware is likely to be the solution to the systems integration gap.
- ◆ Although product support pilots address the use of advanced prognostics and diagnostics for new weapon systems, this is an area of opportunity for deployed and aging weapon systems.
- ◆ Although ASPs are in their early stages, they may prove to be the next eventual step in DoD's applications evolution.
- ◆ Although DoD has begun to experiment with portals, we see this technology as a potential area of opportunity. Close, collaborative supplier arrangements will help to ensure efficient, required support.

On the basis of this assessment, we recommend that the Department

- ◆ monitor the pace at which the Services and agencies adopt middleware technologies,
- ◆ focus additional attention on the use of supplier portals while preventing the erosion of supplier relationships or significant economies of scale,
- ◆ pilot with an ASP provider or test the concept's viability by having one DoD organization buy a common software package and host it for others,
- ◆ establish a program to aggressively promote the incorporation of prognostics and diagnostics into fielded weapon systems, and
- ◆ establish a strategy to diffuse technology, including the results of the Defense Advanced Research Projects Agency's (DARPA) Advanced Logistics Program (ALP) and Ultra*Log project, to appropriate users.

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Chapter 1

Introduction

A main objective of the Assistant Deputy Under Secretary of Defense (Logistics Architecture) (ADUSD[LA]) is to design and coordinate the implementation of a logistics architecture that inherently meets Joint Vision 2010 requirements. This report assesses the impact of new and emerging technologies on the future architecture of DoD logistics.

BACKGROUND

As a precursor to this study, representatives from the University of Maryland's Supply Chain Management Center conducted an industry survey to determine where technology for managing logistics is predicted to be in 2010. They used the results of the survey to develop an exploratory technology forecast,¹ which documents the trends and predictions for technology development and advancement. The results of this work became the "could be" state for DoD logistics.

The forecast identifies four technology trends:

- ◆ Accelerating connectivity will allow transmission of a far greater volume of information at significantly faster speeds and much-reduced cost.
- ◆ Third-party providers will offer smart networks—self-adjusting networks of bundled bandwidth and supply chain applications.
- ◆ In the area of real-time total asset visibility, developing protocols, standards, and operating platforms will enable real-time monitoring of assets.
- ◆ More integrated supply chains will be enabled by pervasive use of collaborative planning, forecasting and replenishment, Web portals, and online market exchanges.

This extremely detailed forecast reviews many technologies that are similar in nature. For example, the report lists five types of high-speed cable. We shortened this list by grouping similar technologies together in relevant categories under each overarching trend. Table 1-1 details the trends and technology categories.

¹ Sandor Boyson and Thomas Corsi, *The Year 2010 Netcentric Supply Chain: An Exploratory Technology Forecast*, University of Maryland, May 2000. This document is reprinted in its entirety in Appendix A.

Table 1-1. Trends and Technology Categories

Connectivity and bandwidth	Smart networks	Real-time asset visibility	Fully integrated supply chain management
Broadband satellite/antenna	Hardware (routers, switches, chips)	Advanced data tagging	Intelligent agents/bots
High-speed cable	Software (artificial intelligence, common protocols)	Advanced data capture	Portals
	Application service providers	Fully integrated prognostics	Middleware Automated messaging and security

The 12 categories in Table 1-1 cover all of the individual technologies in the exploratory technology forecast. For example, the report lists a wide variety of advanced hardware that will be available to the supply chain managers of the future—such as intelligent random-access memory (IRAM) chips, Active Matrix Liquid Displays, and thin clients. All of these technologies would be included in the Hardware subcategory of Smart Networks. In the following subsections, we describe the technologies included in the categories in Table 1-1.

Connectivity and Bandwidth

BROADBAND SATELLITE/ANTENNA

This category includes low orbiting satellites, which will allow global connectivity with short transmission times, as well as a new generation of higher-altitude and geosynchronous satellites that will allow for much faster data transmission. It also includes antenna advances that will coincide with the deployment of the new satellite network.

HIGH-SPEED CABLE

This category groups all land-based connectivity advances under one heading. These technologies include fiber optics, hybrid fiber coaxial cable, Category 5 cable, and Enhanced Performance Category 5 Pair and Unshielded Twisted Pair Cable. All of these technologies will offer much higher bandwidth than today's copper wiring can provide. Some of these technologies, such as fiber optic cable, are in use today—but usually only between major network nodes. By 2010, they will be pervasive.

Smart Networks

HARDWARE

This category includes hardware advances that will enable the use of smart networks: IRAM chips, Active Matrix Liquid Displays, faster Internet routers and switches, and thin client workstations.

SOFTWARE

This category includes artificial intelligence, application switches, and common protocols. Artificial intelligence will allow technology to accomplish tasks without human intervention. Application switches consist of software that enables users to automatically source and use specific functionalities from different application service providers (ASPs) on an as-needed basis. Protocols (such as RosettaNet) are formats and methodologies that enable systems to exchange information.

APPLICATION SERVICE PROVIDERS

This category includes any hosted application. We have purposely excluded supplier exchange portals in this section, however, and we differentiate them on the basis of transactions. A portal is a service that enables a transaction to occur between two or more parties; an ASP is a provider that rents software and server space to a user.

Real-Time Asset Visibility

ADVANCED DATA TAGGING EQUIPMENT

This category includes two-dimensional bar codes, smart bar codes (which include information such as destination/route, date, weight, content, and last dropoff and pickup point, as well as a time stamp), I-Buttons, and smart containers. Smart containers can interact with advanced data tagging equipment on packages within them and make changes to temperature or transmit individual status reports.

ADVANCED DATA CAPTURE EQUIPMENT

Advanced data capture equipment goes hand-in-hand with the previous section. This category includes voice recognition systems, hands-free information capture systems, radio frequency identification systems, and global positioning systems (GPSs).

FULLY INTEGRATED PROGNOSTICS

This category contains all of the technologies that allow vehicles and other equipment to automatically self-diagnose major component systems. These technologies provide advance warning of needed service so that the user can obtain parts prior to any malfunction. An example from the exploratory technology forecast is “smart dust.” Smart dust is a microscopic sensor that will be able to monitor temperature, humidity, and light; be aware of its position via a GPS; and communicate this information through wireless channels.

Fully Integrated Supply Chain Management

INTELLIGENT AGENTS/BOTS

These two new technologies, according to the exploratory technology forecast, are capable of searching corporate and partner databases, retrieving relevant information on a real-time basis, and conducting business transactions according to pre-determined business rules. In essence, they are part of a very advanced search mechanism that can be programmed to seek out specific information, travel through the Internet to find it, and act on it. The use of intelligent agents (IAs), for example, can enable a remanufacturer to get repair parts at specified prices, on time, and in the right quantity—and use fewer human resource hours.

PORTALS

This category includes enterprise information portals (EIPs) and supplier-exchange portals. An EIP, with IAs, is capable of searching internal and external databases and retrieving real-time information. A supplier-exchange portal facilitates business transactions between buyers and sellers.

MIDDLEWARE

The middleware category includes all software that enables computer systems that speak different “languages” to communicate with each other. Although the function of middleware is similar to that of common protocols, we differentiate the two by the way they allow intersystem communication. Middleware takes data from a sending system and filters and transforms it into a form that is usable by a receiving system. Protocols, by contrast, are formats and methodologies that facilitate direct physical exchange of information between systems.

For example, if two systems with common protocols were transmitting data about a shipment, they would have the same format for each piece of information (e.g., the shipment’s weight). If these two systems did not have common protocols, a middleware product could change the format of the shipment’s weight from the sending system to suit the requirements of the receiving system.

AUTOMATED MESSAGING SYSTEMS

The automated messaging category includes technologies that automatically send information from one system to another, including transmissions through e-mail, proprietary electronic data interchange systems, the World Wide Web, or DoD communications networks.

SECURITY

The technologies in this category include Internet Protocol Security (IPS) standards, digital certificates, and user authentication systems. IPS standards allow members to exchange data only with other certified organizations. This arrangement ensures that no data are sent “unattended” over the public infrastructure.

STUDY APPROACH

Our approach included the following steps:

- ◆ *Determine the current state of logistics technology.* As a first step in determining the degree to which DoD will utilize technologies that forecasters expect to be available in 2010, we interviewed functional experts in supply, maintenance, and transportation to understand the current status of technology in each functional area. Together, these functional specialists represent a broad range of experience across each of the Services, the U.S. Transportation Command (USTRANSCOM), the Defense Logistics Agency (DLA), and the Office of the Secretary of Defense (OSD).
- ◆ *Understand the technology implications of guiding documents.* We reviewed three key DoD logistics planning documents: the DoD Logistics Strategic Plan, Joint Vision 2010, and the 2010 DoD Logistics Architecture. We have assessed the technology implications of the objectives, operational capabilities, and business results described in those documents.
- ◆ *Understand Department plans associated with technology.* To identify logistics initiatives with the highest probability of implementation, we reviewed official submissions to OSD and to Congress. These submissions included the Best Commercial Practices 1999 Report to Congress, the Program Objective Memorandum (POM) Tab N-4s and Tab Gs, and the Defense Reform Initiative Directive 54 (DRID 54) responses. From these documents, we have created a master list of initiatives and compared them to trends and technologies in the exploratory technology forecast to determine the probability that DoD would use these future technologies.
- ◆ *Perform a gap analysis between current, planned, and potential logistics technologies.* We present the results of our initiative analysis in the context of the four exploratory technology forecast trends: connectivity and

bandwidth, smart networks, real-time asset visibility, and fully integrated supply chain management. We have linked initiatives with technologies that would make them most effective or world-class and determined that the greater the likelihood that a given logistics initiative will be executed, the greater the likelihood that DoD will embrace the initiatives' most enabling technologies.

- ◆ *Discuss the impacts of the identified gaps.* We determined the degree of alignment between the technology implications of key guiding documents for DoD logistics, the technologies supported by initiatives reported to OSD and Congress in official submissions, and the University of Maryland's exploratory technology forecast recommendations to the Department. We identify opportunity areas for DoD and provide suggestions to facilitate the adoption of enabling technologies.

REPORT FORMAT

The remainder of this report is organized as follows:

- ◆ *Chapter 2* discusses the current status of logistics technology in supply, maintenance and transportation.
- ◆ *Chapter 3* assesses the applicability of the exploratory technology forecast to the technology implications of key logistics documents in DoD: the DoD Logistics Strategic Plan, Joint Vision 2010, and the 2010 DoD Logistics Architecture.
- ◆ *Chapter 4* describes the mechanism for translating the individual initiatives in the Best Commercial Practice 1999 Report to Congress, the POM Tab N-4s and Tab Gs, and the DRID 54 responses to a combined, DoD-wide view and provides a gap analysis between the initiatives and the University of Maryland's technology forecast.
- ◆ *Chapter 5* discusses the degree of alignment between the technology implications of key logistics documents and the results of the gap analysis.
- ◆ *Appendix A* provides the University of Maryland's technology forecast, on which the analysis is based.
- ◆ *Appendix B* provides the master lists of initiatives from official submissions to OSD and Congress.
- ◆ *Appendix C* lists the abbreviations used in the report.

Chapter 2

Current Status of DoD Logistics Technology

BACKGROUND¹

The DoD logistics process is compartmentalized by functions—such as supply, maintenance, and transportation—and from the wholesale level through several retail layers to the warfighter. The information systems that support the logistics functions are similarly compartmentalized and cannot generally support an integrated, end-to-end logistics process. Although some progress has been made in integrating processes and data with supply chain management initiatives, implementation of emerging logistics technology offers the potential for significant improvements.

Many core applications still run in a mainframe environment; adoption of commercial off-the-shelf (COTS) solutions is in the early stages. Implementation time frames tend to be extended, and there is a tendency to resolve differences between COTS processes and Department processes by adding custom code to the COTS application rather than redesigning the internal process.

The most recent attempt to develop standard logistics information systems—the Corporate Information Management initiative—achieved mixed results. Implementation of the Distribution Standard System by DLA, the Global Transportation Network (GTN) by USTRANSCOM, the Transportation Coordinator's Automated Information for Movement System II by the Army, depot maintenance and material management applications, and the COTS manufacturing resources planning (MRPII) initiative for maintenance depots have been successful. Generally, however, these systems are stand-alone applications that do not integrate the logistics functions in an end-to-end fashion. Several recent initiatives also do not provide comprehensive interoperability to support end-to-end logistics processing.

The Defense Information Systems Agency (DISA) is developing a common operating environment (COE) for systems users, as well as a standard operating environment for mainframe legacy systems. Although the logistics community generally accepts the COE concept, the current COE does not meet all logistics requirements.

Data exchange standards that are based on an 80-column format underpin current system interfaces. Online access to management information is restricted almost

¹ Department of Defense, *Logistics Functional Requirements Guide*, August 1998.

exclusively to operating units. Limited user access, poor data quality, and a data ownership mindset hinder Department-wide ability to consolidate data and convert it to useful information. DoD lacks an integrated data repository, a network to ensure secure storage and retrieval of technical data, and business rules that facilitate the distribution of such information.

The logistics community has made limited progress in implementing integrated logistics applications. Department policies do not generally promote data sharing, cross-Service infrastructure, and cooperative business applications.

STATUS

The exploratory technology forecast documents four trends for technology development and advancement: connectivity and bandwidth, smart networks (including hardware and prognostics), real-time total asset visibility, and fully integrated supply chain management. In this section we examine the status of those technologies in supply, maintenance, and transportation.

Supply

CONNECTIVITY AND BANDWIDTH

The supply system historically has been characterized by separate wholesale and retail systems, generally operated with machine-to-machine interfaces supported by a data exchange system based on standard 80-column formats. Current and planned initiatives, such as the Navy's Standard Automated Logistics Tool Set use satellite communication capabilities combined with intelligent gateways and knowledge-based portals to receive and process requisitions and provide online status information and input to in-transit visibility databases. Current property book management initiatives also rely extensively on satellite communications, and wireless communications are part of prototype efforts in many segments of the supply system, including warehouse operations and information exchange between customer and intermediate support activities.

Initiatives such as prime vendor (PV) and virtual prime vendor (VPV) programs are moving away from the standard 80-column data. Some of these approaches, such as medical prime vendor, use commercial identification numbers and status data, while other prototype PV projects use commercial data to provide shipping information to the GTN. The commercial data will be integrated with DoD-unique data and made available to the customer. Several efforts also are underway to use connectivity capabilities and bandwidth capacity to incorporate information from wholesale and retail systems into a seamless supply system via an integrated requirements determination process.

SMART NETWORKS, HARDWARE, AND PROGNOSTICS

DoD is attempting to modernize its wholesale logistics information systems by adopting COTS software packages. MRPII packages are being implemented in the maintenance area not only to improve production planning and operations but also to integrate with supply in terms of repair part requirements and availability. Several current initiatives are attempting to implement COTS enterprise resources planning (ERP) solutions for wholesale supply operations; these initiatives will include the use of ASPs as that capability matures. Some of the prototype ERP systems go even further than wholesale operations and attempt to integrate intermediate supply and maintenance functions while replacing legacy information systems. All of the ERP prototypes have stated objectives to minimize customization of COTS software by reengineering current business processes and adopting best commercial practices.

The Advanced Logistics Program (ALP)—which is not limited to supply—attempts to link logistics processes and information from the warfighter through wholesale systems and in some cases back to the vendor base. Many initiatives under the umbrella of Global Combat Support Services also are linking logistics information throughout the supply chain and utilizing current and emerging technology, coupled with process changes, to improve support and reduce costs.

REAL-TIME TOTAL ASSET VISIBILITY

DoD has made good progress toward achieving total asset visibility by capturing source data at time of origination using a combination of bar codes (including two-dimensional bar codes), optical memory cards, and radio-frequency (RF) tags. Source data are perpetuated in supply and transportation information systems and made available to the customer through supply status and in-transit visibility systems. The wholesale and retail levels have seen improvements in asset visibility. Follow-on initiatives will make information more real-time, and improved business rules and processes will facilitate lateral transfer of assets. Real-time asset status throughout the supply chain will help to integrate functional stovepipes and provide end-to-end visibility and control. This strategy will reduce the need for redundant entry of logistics information at numerous nodes in the supply chain and improve overall data quality.

FULLY INTEGRATED SUPPLY CHAIN MANAGEMENT

Department-wide implementation of integrated supply chain management offers great potential for erasing barriers between the logistics functions: supply, maintenance and transportation. Experimentation with smart portals represents one early step in this process. Several prototypes are attempting to receive customer requisitions and process them for vendor delivery by directly linking items, suppliers, and customers. One prototype even attempts to conduct best-value

sourcing for each requisition on an item-by-item basis. Although smart portals present an opportunity to integrate portions of the supply chain, proliferation of unique portals at the customer and provider levels may make the task of data and process integration more difficult. Other e-commerce initiatives and the development of middleware products offer alternative opportunities for supply chain integration within the Department.

Maintenance

CONNECTIVITY AND BANDWIDTH

Future DoD maintenance operations may make substantial use of satellite communications in areas such as remote condition monitoring, condition reporting, and fault remediation. Several new and retrofit weapon systems are being equipped with sensors and communications capabilities that use satellite communications to provide routine monitoring of system performance parameters. Actual operating characteristics are then compared to expected values to identify pending failures. Logistics systems then respond with appropriate spare parts, equipment, and personnel to make necessary repairs at scheduled times in advance of catastrophic failure. Such monitoring also may enable battlefield commanders to put the most “capable” equipment into more demanding engagements while directing degraded (or potentially degraded) equipment elsewhere. Consideration also is being given to remote remediation of maintenance faults, such as those in software on weapon systems.

SMART NETWORKS, HARDWARE, AND PROGNOSTICS

DoD is actively engaged in introducing prognostics into new weapon systems. The F-22 and the Joint Strike Fighter (JSF) will have substantial prognostic capabilities; the JSF maintenance program will fully integrate such capabilities. These developments are being supported by advanced sensing and onboard communications systems (e.g., high-speed data busses). Prognostic capabilities also are beginning to be developed for fielded (or legacy) systems; these prognostic systems will use weapon systems’ performance, maintenance, and reliability databases to detect and predict the future health of systems, subsystems, and components. Several initiatives are exploring this potential; the Army Diagnostic Improvement Program appears to have made the most progress.

REAL-TIME TOTAL ASSET VISIBILITY

Automatic identification technology (AIT) is being applied across DoD’s entire range of maintenance operations. Technologies such as bar codes, contact memory buttons, and RF tags are being used to provide a link between products being maintained and information about those products (down to the serial number level). In some cases, data will travel with the product (e.g., in a contact memory button affixed to a part); in other cases, AIT marking will provide the “social

security number” of the product, enabling all information about that product to be maintained and accessed from a central database. AIT is enabling a new attack on serial number tracking in support of maintenance operations. It will provide the ability to link maintenance history, reliability information, usage factors, and technical data directly to a specific, unique part (or component). It also will enable entry of source data by maintainers to degrees of accuracy and completeness heretofore impossible to achieve.

FULLY INTEGRATED SUPPLY CHAIN MANAGEMENT

While we have a long way to go, maintenance information systems are beginning to be integrated with the entire logistics support process. For example, the initial interrogation of a maintenance fault (using a portable maintenance aide) may result in immediate identification of technical data required for the repair, the equipment and skills that should be used, and particular performance characteristics of the failed system (and similar systems throughout DoD). When parts are needed, the maintenance system will automatically send the requisition and provide tracking capability. Effort expended, costs incurred, and other logistics management data will be captured automatically in an enterprise information system.

Transportation

CONNECTIVITY AND BANDWIDTH

The DoD AIT Integration Plan and related prototype demonstrations have laid out a roadmap for the use of AIT devices, satellite communications, and linked data systems to provide visibility of cargo from the source to the ultimate user. Commercial satellite tracking systems provide the capability to track and locate materials and vehicles in the logistics pipeline in near-real time. In addition, these satellite systems provide digital communication capability to vehicle drivers. The integration plan also lays out an architecture for moving logistics pipeline data among the distribution nodes.

An example of one satellite system is the Defense Transportation Tracking System (DTTS), operated by the Navy. The DTTS monitors continental United States (CONUS) movement of arms, ammunition, and explosive shipments by commercial carriers. These shipments are considered to be of high value, sensitive in nature, and potentially dangerous to the general public. DoD has determined that knowing their location at all times is essential and requires origin-to-destination monitoring of such shipments. The technology also can be used to track other kinds of shipments and items as the need and desire develops.

SMART NETWORKS, HARDWARE, AND PROGNOSTICS

Contact memory technology integrated with RF data communication facilitates capture of source information in the logistics pipeline and transmission of that

data to remote automated information systems for near-real-time update. This emerging capability also accommodates the use of hand-held terminals (HHTs) to collect and move logistics information, including data related to transportation. Contact memory technology has been used for several years and more recently has been integrated with HHTs and other technology to move data through the supply chain.

REAL-TIME TOTAL ASSET VISIBILITY

Development and deployment of the GTN provides the capability to integrate logistics information from disparate databases for use by the commanders-in-chief and other operational organizations. Current efforts are designed to fuse this information into a cohesive common operational picture. As more and more material is being provided directly from commercial sources to the customer, USTRANSCOM has developed several prototypes to capture commercial data and integrate it with DoD standard data in the GTN. These prototypes are using Extensible Markup Language (XML) to facilitate collection and display of the commercial data. The GTN currently captures more than 80 percent of unit moves and DoD CONUS shipments and 70 percent of commercial carrier movements; it is rapidly improving the visibility of vendor shipments.

DoD continues to expand its use of linear and 2D bar codes with commercial standards and is making greater use of RF identification (RFID) technology—active and passive—for tracking and providing visibility of material in the logistics pipeline. New capabilities—such as common access cards (smart cards) for electronic transfer of standard manifest data from origin and commercial electronic data interchange (CEDI) to communicate data from the commercial carrier prototypes—also are being incorporated to provide real-time total asset visibility.

FULLY INTEGRATED SUPPLY CHAIN MANAGEMENT

The Strategic Distribution Management Initiative (SDMI) is a major program of USTRANSCOM and the Defense Logistics Agency (DLA) to integrate the distribution portion of the supply chain. The Strategic Air Distribution Test, which will expedite and track air cargo to Europe, will integrate bar codes, RFID, and other technology. Another key supply chain management initiative is a prototype whereby a third-party logistics (3PL) provider moves authorized freight and uses CEDI to move and manage related data.

USTRANSCOM also intends to pursue an Advanced Concept Technology Demonstration (ACTD) to improve the Defense Transportation System (DTS). While not yet funded, the goal of the project is to find ways to reduce deployment time, support transportation mode selection, provide global optimization, and provide integrated logistics and operations using database integration, decision support tools, AIT, and infrastructure.

USTRANSCOM also is pursuing the development of a Business Decision Support System (BDSS) to provide integrated performance information about the DTS. The BDSS will be Web-based and will support the USTRANSCOM Business Center's and the Joint Movements Control Group's intermodal decision-making ability.

SUMMARY

Ongoing technology-related initiatives and prototypes offer great promise for helping DoD overcome the challenges that the current lack of integration and interoperability present to effective supply chain management. These efforts will enable greater responsiveness to warfighter requirements and increase the efficiency at which DoD operates the supply chain.

Chapter 3

Logistics Vision Documents

The concept for the future DoD infrastructure is based on key DoD strategic/vision documents: the DoD Logistics Strategic Plan, Joint Vision 2010 and the 2010 DoD Logistics Architecture. In this chapter, we address the technology implications of each.

DoD LOGISTICS STRATEGIC PLAN

The DoD Logistics Strategic Plan is one of the primary logistics planning documents within the Department of Defense. It provides unified guidance for logistics-related initiatives and identifies end-state characteristics and objectives.

End-State Characteristics and Objectives

The vision in the FY00 plan states that by FY06 joint logistics will be a highly efficient system that ensures required support to the warfighter. This system will have a fully integrated supply chain that will ensure products and services efficiently meet joint warfighting needs. Improved reliability, shortened processing cycles, agile manufacturing, flexible maintenance, and time-definite delivery will replace large investments in inventories and personnel. “Best value” logistics providers will directly satisfy warfighting requirements. DoD will incorporate commercial practices and take advantage of technologies and advanced methods developed in that sector. There will be widespread access to information and common information interfaces, and a logistics Integrated Data Environment will facilitate cooperative efforts with the private sector and among the DoD components.

To achieve this end-state, DoD will pursue the following objectives:

- ◆ Optimize support to the warfighter through improved mission-capable (MC) rates
- ◆ Increase airlift, sealift, and afloat prepositioning capacity to improve strategic mobility to the warfighter
- ◆ Decrease time between order request and order fulfillment by implementing customer wait time (CWT) as the key logistics metric

-
- ◆ Increase access to information about items in storage, in process, and in transit by fully implementing joint total asset visibility (JTAV) across DoD
 - ◆ Maximize the utility of logistics processes and systems through reengineering and modernization, and
 - ◆ Reduce maintenance, supply, distribution, transportation, and logistics-related combat costs while continuing to support warfighter requirements.

Technology Implications

To ensure required support, the DoD Logistics Strategic Plan implicitly mandates development of a network that supports widespread access and information sharing. This network must integrate a vast DoD logistics pipeline made up of disparate nodes. It must facilitate timely collection of information that will provide insight into existing processes and provide decision makers with critical information in real time.

Five of the six Strategic Plan objectives can be effected, at least in part, through technology: MC rates, CWT, asset visibility, efficiency of logistics processes, and logistics costs.

Systems that support collaborative planning and information sharing between “links” in the supply chain can facilitate time-definite supply of consumables and reparable to help improve MC rates. This guaranteed supply can decrease logistics costs by reducing the need for premium product pricing, premium transportation, and frequent expediting.

Middleware enables connectivity and integration, which—coupled with real-time information and system access—can improve asset visibility. Web portals facilitate real-time simultaneous processing that can help minimize overall CWT and generally shrink the cycle time of each component process. Intelligent agents can diagnose processes that fall below standards, report anomalies throughout the network, and trigger corrective action, thereby improving the efficiency of those processes.

JOINT VISION 2010

The Joint Vision 2010 document contains a comprehensive portrait of how DoD military engagements will occur in the future and describes—but does not prescribe—co-requisite operational capabilities.

Overarching Goal and Operational Capabilities

Full spectrum dominance is the primary goal of the Joint Vision, and achieving it will depend on development and diffusion of information technology, as well as technical innovation. Full spectrum dominance requires the presence of four operational capabilities:

- ◆ *Dominant maneuver.* Dominant maneuver occurs when forces are able to use speed and operational tempo to gain military advantage.
- ◆ *Precision engagement.* Precision engagement occurs when sensors and systems work in concert to provide specific results during military operations.
- ◆ *Focused logistics.* Focused logistics occurs when assets are provided in the right quantity and quality, at the right time, and in the correct location during military operations.
- ◆ *Full-dimensional protection.* Full-dimensional protection occurs when all assets involved in military operations—people, equipment, supplies, and systems—are secure.

Of these desired operational capabilities, focused logistics is the most pertinent to this assessment. Planned efforts through FY06 to support focused logistics include implementation of systems to support end-to-end processing, the capability to support time-definite delivery, AIT to provide TAV, and a Web-based, shared data environment to enable real-time or near-real-time information availability.

21st Century Challenges

To support Joint Vision implementation, 21st century challenges were detailed for each of the desired operational capabilities. Aspects of the future warfare environment for which there is a particular technological requirement or that technology potentially can support or solve include the following:¹

- ◆ There will be a wider range of interoperability requirements with multinational, interagency, and nonstate partners.
- ◆ Planning and execution time will be reduced.
- ◆ There will be significant resources and capabilities outside DoD.
- ◆ Integrated information architectures will proliferate.

¹ The Joint Chiefs of Staff, *Joint Vision Historical Documents* [cited October 2, 2000]. Available as <http://www.dtic.mil/jv2020/history/challenges.ppt>.

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- ◆ Advanced integrated information technology and communications will be available to logistics forces.
 - ◆ Increased worldwide connectivity will permit improved information exchange.
 - ◆ 21st century adversaries will rely more on information and information systems.
 - ◆ The United States, its allies, and partners will be more vulnerable to adversary information operations as our dependence on technology increases.
 - ◆ Rapid crisis response will be required to enhance stability.
 - ◆ Force projection strategies will be based on continuing reduced forward presence and dependence on en route infrastructure.
 - ◆ Coalition operations with many participants will be more common.
 - ◆ Logistics resources will be more limited.

Technology Implications

There are significant technology implications to successfully achieving focused logistics. Real-time monitoring of all assets and materials in DoD supply chains will require massive amounts of bandwidth. Asset information is only as accurate as the underlying processes that affect its quantity, location and timing, so planning, procurement, stocking, and distribution transactions must be processed in real time or near-real-time.

To support real-time processing and data availability, focused logistics will require an unprecedented level of connectivity—from the warfighter to the factory. Anything short of this level of connectivity will limit the ability to attain a comprehensive view of logistics efforts across DoD. This connectivity will require middleware to integrate the many disparate information systems throughout DoD and industry, allowing the Services, allies, and commercial partners to be interoperable, with information flowing between the appropriate entities in a highly automated fashion. This massive data-sharing effort will entail an equally broad challenge for data, information, and system security. System up-time assurance and the ability to avert information operations by adversaries will be vital.

The effectiveness of a network that supports widespread access to real-time processing and information increases if underlying processes are running at optimal levels. Focused logistics implies a need for systems and networks that support concurrent and collaborative planning, as well as simultaneous processing of the fulfillment/execution elements of logistics. Support systems that automate rules-

based logistics decisions and decision support systems that can offer results-based alternatives will support better, faster decision making and improve overall support to the warfighter.

2010 DoD LOGISTICS ARCHITECTURE

The ADUSD(LA) retained SAIC to develop a logistics architecture to support the operational capabilities outlined by Joint Vision 2010. In July 2000, SAIC provided a Phase 1 deliverable in a briefing titled *Meeting the Challenge: Preparing a Logistics Architecture to Meet the Requirements of Joint Vision 2010*. Based on feedback received from the Services, SAIC updated this deliverable in August 2000. We refer to this product as the 2010 DoD Logistics Architecture.

Overarching Business Rules

The 2010 DoD Logistics Architecture proposes business rules by functional area, organization, and class of supply. Business rules for which there is a particular technological requirement or that technology can potentially support include the following:

- ◆ Commercial providers input shipments into automated global in-transit visibility (GTV) system (e.g., Joint Total Asset Visibility [JTAV]/GTN)
- ◆ Intelligent, automated decision capability availability
- ◆ AIT fully implemented
- ◆ Increased reliance on diagnostics and prognostics
- ◆ National provider responsible for management from source to customer
- ◆ National provider and Services focus on managing information and suppliers vice managing stock
- ◆ GTV provides total visibility of materiel in storage, in transit, in maintenance, under contract, in acquisition, and in theater until issued to customer
- ◆ Maximizes use of PV, VPV, and direct vendor delivery (DVD) and dedicated vendors, with provisions of inventory visibility and management assistance
- ◆ Reliance on combination of commercial/DoD depot sources (e.g., PV and VPV) for total life-cycle management (storage, reliability assessment, repair, distribution)

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- ◆ No logistics build-up ashore for operational maneuver from the sea (OMFTS)
 - ◆ Logistics support for operations ashore provided from sea-based deployment blocks (stocks) and logistics service capabilities tailored for mission
 - ◆ Resupply of sea-based stocks and supplies for nonstocked items ordered from intermediate staging and supply bases or from CONUS, using logistics systems
 - ◆ Acquisition by single DoD procurement system
 - ◆ Maximum use of credit cards (in-theater)
 - ◆ Maximum use of best commercial practices (e-commerce, information security services).²

Technology Implications

The 2010 DoD Logistics Architecture identifies several technology-related architecture challenges:

- ◆ Current inability to fully support focused logistics
- ◆ Ensuring that supporting information technology is state-of-the-art
- ◆ Ensuring that current disparate logistics systems are consolidated and information is integrated
- ◆ Ensuring that information management systems are pervasive, reliable, and interoperable
- ◆ Ensuring that systems are scalable.

These challenges, coupled with the business rules and overarching operational requirements, have several specific technology implications.

The 2010 DoD Logistics Architecture clearly identifies the need for AITs, including bar codes, to streamline processes and provide visibility. It regards prognostic and diagnostic technology as essential for real-time maintenance information and requirements. The architecture also sees a definite role for satellite technology to support initiation of a request for information, supply, or support from a mobile or stationary unit and receipt of status information by the sending unit.

² SAIC, *Meeting the Challenge: Preparing a Logistics Architecture to Meet the Requirements of Joint Vision 2010*, July and August 2000.

The absence of logistics build-up ashore for OMFTS and an emphasis on managing information rather than items require real-time data access, system assurance, and direct communication with the appropriate source of supply (DoD or commercial). Reductions in on-hand supply imply an operating environment that is essentially error-proof. The network must provide whatever is needed, whenever it is needed.

The emphasis on commercial support translates to online (Web-based) communication, planning, and ordering with commercial vendors, service/maintenance facilities, distribution facilities, and transportation providers (including freight consolidators). Expanded PV, VPV and DVD relationships underscore the need for vendors to provide shipment information to the GTN and for the GTN to be completely integrated with other logistics systems.

Maximum use of procurement cards in theater means that the card provider must transmit detailed buy data into the single DoD procurement system to help ensure that a complete picture of logistics requirements is available. The single procurement system translates to integration of existing procurement systems or replacing them all with a single COTS product.

The network solution must be completely integrated so that it permits source-to-customer asset visibility, including reparables, life-cycle management, and central coordination for organizations such as the proposed national transportation authority, the national provider, and the supply chain operations center. Where possible, the network must use decision-support systems to provide better, faster support to the warfighter.

Maximum use of best commercial practices such as e-commerce implies expanded use of portals, Web exchanges, and ASPs. Although DoD must take appropriate steps to ensure that these options provide appropriate levels of security, it should make every effort to not reduce the benefits offered by such practices by imposing onerous reporting requirements or multiple layers of management.

SUMMARY

The DoD Logistics Strategic Plan, Joint Vision 2010, and the 2010 DoD Logistics Architecture serve as guides for the future of DoD logistics. Joint Vision 2010 reaches beyond logistics and describes general operational capabilities that must exist in the future DoD environment. The DoD Logistics Strategic Plan focuses on several high-priority goals for the near term that will ultimately serve as building blocks for the broader vision. The 2010 DoD Logistics Architecture explicitly uses the Joint Vision operational capabilities as functional design requirements.

In Chapter 4, we take a closer look at planned DoD initiatives and assess the probability that they will utilize the forecasted technologies.

Chapter 4

Methodology and Analysis

In this chapter we focus on how DoD's logistics plans may utilize future technologies. The likelihood of implementation was a key factor in deciding which Service, USTRANSCOM, and DLA initiatives to assess within the framework of the exploratory technology forecast results. We describe our methodology and present the results within the context of the four University of Maryland exploratory technology forecast trends: connectivity and bandwidth, smart networks, real-time asset visibility, and fully integrated supply chain management.

We associated technologies with initiatives on the basis of their ability to serve as differentiating enablers. That is, we linked initiatives with technologies that would make them most effective or world class. The greater the likelihood that a given logistics initiative will be executed—as indicated by initiative reporting and funding in official reports to OSD and Congress—the greater the likelihood that DoD will embrace the initiatives' most enabling technologies.

METHODOLOGY

Initiatives Determination

To identify logistics initiatives with the highest probability of implementation, we reviewed official submissions to OSD and Congress. These submissions included the Best Commercial Practices 1999 Report to Congress, the Program Objective Memorandum (POM) Tab N-4s and Tab Gs, and the Defense Reform Initiative Directive 54 (DRID 54) responses. From these documents, we created a master list of initiatives and compared them to the trends and technologies in the exploratory technology forecast to determine the probability that DoD would use these future technologies.

We did not assess logistics plans that the Services, USTRANSCOM, and the DLA did not include in these official documents. We understand that there may be other logistics initiatives in internal, Service-specific planning documents that might utilize the technologies identified in the exploratory technology forecast. We concluded, however, that the best way to create an accurate, parallel picture across DoD was to use official submissions.

CREATING MASTER LISTS OF INITIATIVES

DoD Logistics Strategic Plan Objectives

We began the process by defining the six DoD Logistics Strategic Plan objectives as subheadings that we would use to make the potentially large list of Department initiatives more meaningful and manageable. The six objectives are as follows:

- ◆ Optimize support to the warfighter
- ◆ Improve strategic mobility
- ◆ Implement CWT
- ◆ Fully implement joint total asset visibility across DoD
- ◆ Reengineer/modernize applicable logistics processes/systems
- ◆ Minimize logistics costs while meeting warfighter requirements.

Although an initiative might support several different objectives, we determined that we would assign each initiative to the single objective it best supported to eliminate the possibility of double-counting during analysis.

Logistics Initiatives

Next we reviewed the Best Commercial Practices 1999 Report to Congress, the POM Tab N-4s and Tab Gs, and the DRID 54 responses to compile a list of logistics-related initiatives contained therein. We assigned the initiatives to the most appropriate DoD Logistics Strategic Plan objective in a master list for each Service or agency, noting which were funded and which were not. Funding became a factor later in the study when we assigned scores to the likelihood of initiative implementation. For example, an initiative that the DRID 54 reported and noted as funded received a higher score than an initiative that was reported without an indication of funding. Our rationale was that the initiative had a greater likelihood of proceeding with funding than without it.

Appendix B contains the master list of initiatives for each of the Services, USTRANSCOM, and the DLA.

PROCESSING THE MASTER LISTS

Product Support Pilots

The first step in processing the individual master lists was to separate out initiatives that represented product support pilots. Because senior Department leaders envisioned that these pilots would be monitored differently than conventional

logistics initiatives, we believed that handling their analysis separately would be appropriate.

The ultimate goal of product support is to optimize customer support, achieve maximum weapon system availability at the lowest total ownership cost (TOC), improve operational performance, and increase readiness. The status updates in *Product Support for the 21st Century: A Year Later*¹ show that the current focus is on management of the support function and performance arrangements between the weapon system user and the logistics provider. Implementation of the pilots will occur during Phase II of the overall project, which runs from FY00 through FY02.

Maintenance of Legacy Systems

We then removed initiatives that clearly dealt with maintenance of legacy systems. This task focuses on how likely DoD's logistics initiatives are to incorporate future technologies; therefore, we did not want to include initiatives that dealt with prolonging the life cycle of the legacy environment. If an initiative dealt with upgrading a legacy system to a more modern system, however—such as to a COTS ERP package—we included it in our analysis under the Reengineer/Modernize Applicable Logistics Processes/Systems strategic objective.

Functional Expert Review

Next we reviewed the individual master lists with functional experts to ensure that the initiatives did have a technology implication, were associated with the correct DoD Logistics Strategic Plan objective, and were combined appropriately when they had different titles in different submissions. This latter element was of particular concern because in many cases an initiative from one source had a different (albeit similar) name from an initiative in another source. For example, initiatives to implement the CWT metric were listed in different submissions as lead-time reduction, implement CWT, and time-definite delivery (TDD). Our specialists were able to distinguish when these similarly titled initiatives were distinct and when they were duplicates.

Probability of Implementation

The foundation of this analysis is that the more frequently the Services, USTRANSCOM, and the DLA state in official submissions that they plan to implement a given logistics initiative and report associated funding, the greater the likelihood of actual implementation. Therefore, we were careful to account for the fact that an initiative appeared in more than one source document. We used a scoring system to ensure that final results would reflect the number of times official submissions contained a specific initiative. For example, we awarded an

¹ Department of Defense, *Product Support for the 21st Century: A Year Later*, September 2000.

initiative more weight if it was listed in the DRID 54 and the POM Tab G than if it was listed in the DRID 54 only. Furthermore, an initiative that was reported and noted as funded in the DRID 54 received a higher score than an initiative that was reported without an indication of funding.

DoD-Wide Initiatives

At this point in the process, we had a comprehensive list of relevant logistics initiatives by Service and agency, each with an overall score. The next step was to combine the initiatives from the Services, USTRANSCOM, and the DLA into a single document reflecting a Department-wide view of logistics plans.

After merging all of the initiatives by DoD Logistics Strategic Plan objective into one list, we combined similar initiatives from the separate organizations. For example, if the Army and Navy both had initiatives to implement TAV, we combined these initiatives under a single heading and aggregated their scores.

Technology Alignment

Our final task was to associate the Department-wide list of logistics initiatives with technologies from the exploratory technology forecast. We conducted a line-by-line assessment of initiatives and made a determination about whether a given technology would best enable their success. We assigned a weighted score to each unique combination of initiative and technology, based on the reporting and funding scores from earlier analysis. We summed the individual initiative scores at the DoD Logistics Strategic Plan objective level and then summed the totals for each technology. Table 4-1 provides the objective/technology matrix.

ANALYSIS

Logistics Objectives

The Initiatives Totals column in Table 4-1 indicates the cumulative score for the initiatives within each objective. These scores reflect the extensiveness of initiative reporting and funding.

As the table shows, there appears to be less activity associated with minimizing logistics costs while meeting warfighter requirements (20), implementing CWT (24), and improving strategic mobility (33) than with the other logistics objectives. Total asset visibility and optimizing support to the warfighter show moderate levels of activity, with scores of 70 and 74, respectively. Most of the activity, however, appears to relate to reengineering/modernizing logistics processes and systems, as the score of 110 reflects.

Table 4-1. Summary Results

Program	Initiatives totals	Connectivity and bandwidth		Smart networks			Real-time asset visibility			Fully integrated supply chain management			
		Broadband satellite/ antenna	High speed cable	Hardware (routers, switches, chips)	Software (artificial intelligence, common protocols)	Application service providers	Advanced data tagging	Advanced data capture	Fully integrated prognostics	Intelligent agents/ bots	Portals	Middleware	Automated messaging and security
Optimize support to the warfighter	74	32	22	13	48	22	27	23	31	36	18	43	58
Improve strategic mobility	33	28	0	0	8	0	27	27	0	31	3	0	29
Implement customer wait time	24	0	0	0	24	22	14	12	12	24	22	12	22
Total asset visibility	70	67	55	55	9	0	52	61	14	6	0	52	70
Re-engineer / modernize applicable logistics processes / systems	110	19	17	93	23	59	23	23	11	102	88	102	106
Minimize logistics costs while meeting warfighter requirements	20	9	6	0	4	6	10	10	0	18	12	12	12
Totals	331	155	100	161	116	109	153	156	68	217	143	221	297
Trend averages		128		129			126			220			

Because we associated each initiative with only one objective, the scores do not reflect how successful execution of an initiative in support of its primary objective may positively affect other objectives. For instance, DoD's successful modernization of a logistics system may very well reduce CWT, provide additional asset visibility, increase levels of support to the warfighter, and reduce overall logistics costs.

Furthermore, there is wide variation in the scope of the objectives. Objectives that are narrowly defined seem naturally to require fewer sweeping modifications and thus less overall effort and funding than objectives that have broader scope. For example, although CWT will require coding changes in multiple legacy systems, it will not require the breadth of changes that are associated with modernizing a suite of logistics systems. A lower score for an objective, therefore, does not necessarily mean that it is not receiving the appropriate level of attention from the Services and agencies.

Technologies

The Totals row for all columns to the right of the Initiatives Totals column provides the overall scores for the technology trends.

The average scores for the first three technology trends are surprisingly equal. Connectivity and bandwidth averages 128, smart networks averages 129, and real-time asset visibility averages 126. More activity appears to relate to fully integrated supply chain management than the other three trend areas; three of the four subcategories scored more than 200, and the overall average was 220. The fully

integrated supply chain management average is 75 percent greater than that of real-time asset visibility (the category with the lowest average).

Because there appears to be such a large disparity between fully integrated supply chain management and the other three technology trends, we believe that addressing them separately is appropriate.

CONNECTIVITY AND BANDWIDTH, SMART NETWORKS, AND REAL-TIME ASSET VISIBILITY

Within the three lowest-averaging areas, half of the component technologies have fairly equal scores, and the other half have scores below the average of the three trends (128).

The technologies with comparable scores are hardware (161), advanced data capture (156), broadband satellite/antenna (155), and advanced data tagging (153). Interestingly, all of these areas are data-related. They involve the identification, acquisition, and rapid transmission of data. Although these technologies are important regardless of location, the potential impact for DoD may be greatest for mobile and distributed data-in-transit, in prepositioned locations, and on the battlefield. Comparable efforts appear to be allotted to technologies that taken in combination will provide the Department with improved information that will facilitate superior decision making—which is regarded as an encouraging result.

Technologies with scores below the three-trend average are software (116), ASPs (109), high-speed cable (100), and fully integrated prognostics (68). We define these technologies as gap technologies and potential areas of opportunity for DoD.

Software (Artificial Intelligence and Common Protocols)

Although this score falls below the three-category average of 128, not surprisingly it is not far below that score. DoD is fairly active in its software efforts. The Department is beginning to implement COTS ERP software packages and continues to refine its MRPII initiatives for maintenance and production (primarily ordnance) activities.

Artificial intelligence in the logistics arena appears to be virtually nonexistent, and DoD generally does not have common protocols. Numerous logistics systems exist, most of which were developed independently from each other and, in most cases, were not designed to integrate with the others. Not surprisingly, these systems operate with a variety of protocols. Under the Clinger-Cohen Act, far fewer internal development and modernization efforts are being proposed or approved. Common protocols, therefore, may not be likely solutions for the Department's interoperability challenges. Middleware is being used by industry to solve

non-common protocol problems, and the high score for middleware (221) indicates that this approach is a likely solution for DoD as well.

Application Service Providers

ASP technology received a score of 109. This low score is not surprising, for several reasons. From an applications perspective, DoD initially custom coded applications that supported batch processing, then later updated the custom code to support real-time or near-real-time data processing; more recently, the Department has been procuring COTS packages. DoD has not traditionally implemented cutting-edge commercial technologies, although its Advanced Technology Demonstrations are designed to demonstrate the maturity of such technologies. ACTDs, by contrast, purposely limit their assessments of military utility to mature technologies. Although the industry is in its infancy, ASPs may prove to be the next step in the Department's applications evolution.

ASPs rent software functionality to customers over a public or private network. The ASP provider owns the software code and is responsible for maintaining the network. ASPs currently offer more than 80 different types of applications including general business software, document management software, ERP packages, and cross-industry niche software. Although small and mid-sized firms are currently the primary users of ASPs, some Fortune 500 firms also have begun to use them.

Table 4-2 summarizes the many competing factors to consider in evaluating the use of an ASP.

Table 4-2. Benefits and Potential Drawbacks of ASPs

Benefits	Potential drawbacks
Does not require a large up-front investment	Most ASPs have minimal experience
Requires minimal resources and talent for implementing and managing an application	Lack of successful use of ASPs on a large scale
Permits rapid implementation	Supports only minimal software customization
Shifts responsibility for upgrades to ASP provider	Permits ASP provider to determine schedule for upgrades
Allows a company to "test drive" a particular software	Cedes data and network control to provider

High-Speed Cable

Although the score for high-speed cable (100) is low compared to that for other technologies, this result is not altogether unexpected. Because cable-related initiatives seem more appropriate for Command, Control, Communications and Intelligence (C3I) initiatives, it is likely that the C3I community reported them. Furthermore, we associated technologies with initiatives on the basis of their

ability to serve as differentiating enablers. In most cases, cable does not serve as the primary enabling technology.

Fully Integrated Prognostics

Table 4-1 shows that fully integrated prognostics received the lowest score (68) of all the technologies. We handled initiatives that represented product support pilots separately from the others. We expected that the pilots would have the most positive effect on this technology's score. We found, however, that because the pilots have the potential to use the vast majority of the technologies, they affect all of the technologies equally. Therefore, the pilots did not provide a discriminator between technologies; they did not change the rankings of the technologies relative to each other.

The DoD report *Product Support for the 21st Century: A Year Later* provides an overview for and update on each of the 30 pilot programs. More than two-thirds of the pilots identify reliability-centered maintenance, sensors, monitoring, on-board prognostics and diagnostics, operational readiness, improved reliability, or performance-based support for weapon systems as an element of their product support strategy. This DoD status report sends a clear message that the product support pilots will incorporate advanced prognostic and diagnostic capabilities.

With the exception of the product support pilots, however, the Services and agencies do not seem to have identified major initiatives for upgrading prognostic and diagnostic capabilities in fielded weapon systems. Deployed systems and especially aging weapon systems could benefit from the improved information and reliability that prognostics and diagnostics offer. These capabilities will allow performance data to be available to the user, DoD support organizations, and external suppliers in near-real-time, reducing the cycle time to provide parts needed for repair efforts. With greater focus on prognostics and diagnostics for fielded weapon systems, the Department would take advantage of a tremendous opportunity for achieving improved warfighter support.

FULLY INTEGRATED SUPPLY CHAIN MANAGEMENT

DoD appears to be focusing technology initiatives on fully integrated supply chain management more than on the other three trend areas. Initiatives within this category generally represent internal integration efforts rather than external integration with commercial providers. In this regard, DoD is no different than industry. For-profit enterprises also tend to resolve internal integration issues before they focus resources on integrating with suppliers and customers. With the preponderance of systems and organizations within DoD and the Joint Vision focus on interoperability, most efforts, encouragingly, appear to support internal integration.

Middleware

Middleware received the highest score (297) of the individual technologies in this trend. This technology allows an organization to bridge the interoperability gaps that non-common protocols create. It can work within an organization as well as between the organization and its supplier or customer network. Interoperability issues are more likely to occur across organizations than within them, but conglomerates, holding companies, or companies with multiple divisions operating on different systems also may encounter these problems. We recognize that within DoD, middleware will be a key enabler to overcoming interoperability issues that the multitude of disparate systems and organizations present.

Intelligent Agents/Bots

Intelligent agents enable business rules to drive information searches and trigger workflow, such as transactions processing. DoD's priority system for requisition processing is one simple example: Requisitions with a higher-priority code are processed before those with lower-priority codes. Although business rules often are difficult to define and articulate, they facilitate processing without labor-intensive intervention.

Within DoD, there is tremendous potential for business rules to enhance supply chain integration. For example, business rules could automate redistribution of shared assets, ordering and shipping of supplies to support scheduled preventive maintenance, and dispatching of vehicles to retrieve secondary items in need of repair. Expanding this concept to information searches, this technology offers the potential, for example, for an item's inventory level to automatically trigger a Web search for the same item, in specific quantities, at a particular price, from a certain pool of vendors. Upon retrieval of this information, business rules determine the "best value" provider and transmit the order to that supplier. In view of the Department's 2.25 billion annual logistics electronic transactions, we see great potential for this technology to advance supply chain integration efforts.

Automated Messaging and Security

Automated messaging and security enable automatic, protected transfer of information from one system to another. This transfer includes transmissions across e-mail, proprietary electronic data interchange (EDI) systems, the World Wide Web, and DoD networks. Clearly, automated messaging is inextricably linked to common protocols or middleware. Where one system may have triggers that automatically send information to a second system to "read" and process that information, the second system must either operate with the same protocol or be connected to the first via middleware.

Although protection of information during transfer is important to all organizations, because of the nature of DoD's mission it is critical for the Department.

This issue will be one of the greatest potential challenges as DoD extends its supply chain integration efforts to its supplier network.

Portals

Portals typically are an organization's electronic link to its suppliers—but without dedicated system-to-system connections. The portal acts as a gateway through which an organization can send orders and request status updates and a supplier can retrieve orders, provide status information, and present invoices. Although portals have similar security issues as those for automated messaging, an effective portal is designed to ensure that users retrieve only information intended for them.

Portals received the lowest score (143) within the integrated supply chain management trend; although DoD has begun to experiment with portals, we see this technology as a potential area of opportunity. The Navy has successfully executed reverse auctions through the FreeMarkets portal, and several of the Department's key contractors—Boeing, Lockheed Martin, Raytheon, and BAE Systems—recently formed a Web exchange, Exostar, for aerospace and defense. Although the exchange initially will support only indirect procurement transactions, the intent is to expand it to include direct procurement, auctions, and collaboration. The exchange eventually will support as many as 37,000 suppliers. Portals are among the most rapidly expanding supply chain technologies—and they represent a technology that can benefit DoD.

SUMMARY

Enabling technologies associated with logistics initiative reporting and funding in official reports to OSD and Congress appear to indicate that there is greater overall emphasis on fully integrated supply chain management than there is on connectivity and bandwidth, smart networks, and real-time asset visibility.

Within these lesser-emphasized areas, there appears to be moderate but equal emphasis on technologies related to data tagging, capture, and transfer. Apparent technology gaps in high-speed cable will likely be addressed through the efforts of the C3I community. True technology gaps appear to exist for common protocols, diagnostics and prognostics, and ASPs. Although the product support pilots will address the prognostic and diagnostic gap for new weapon systems, these technologies represent an area of opportunity for deployed and aging weapon systems.

Within fully integrated supply chain management, a technology gap seems to exist for supplier portals. Sufficient attention appears to be provided to middleware, intelligent agents/bots, and automated messaging and security.

In Chapter 5, we explore the implications of these findings and address additional factors that may affect the speed and degree to which DoD embraces the technologies forecast to be available in 2010.

Chapter 5

Conclusions

INTRODUCTION

In this chapter, we assess the degree of alignment between the technology implications of key guiding documents for DoD logistics, the technologies supported by initiatives reported to OSD and Congress in official documents, and the University of Maryland's exploratory technology forecast recommendations to the Department. Where there appears to be less-than-moderate alignment, we offer suggestions to facilitate the Department's adoption of technologies that will support the operating environment of 2010.

IMPLICATIONS AND RECOMMENDATIONS

In Chapter 3, we review three key documents guiding the future DoD infrastructure: the DoD Logistics Strategic Plan, Joint Vision 2010, and the 2010 DoD Logistics Architecture. We determine the technology implications for the objectives, operational capabilities, and business rules that these documents present. Table 5-1 summarizes these implications.

Table 5-1. Summary of DoD Guiding Document Technology Implications

DoD Logistics Strategic Plan	Joint Vision 2010	2010 DoD Logistics Architecture
Middleware Intelligent agents Systems that support collaborative planning and information sharing between supply chain partners Portals	Connectivity and bandwidth Middleware Rules-based logistics decision capability Decision-support systems Security Systems that support collaborative planning Real-time and simultaneous processing	Satellite technology Integrated systems Decision-support systems System assurance Systems that enable direct links to sources of supply Portals and exchanges Application Service Providers (ASPs) Real-time data access Web-based communication, planning and ordering Automated identification technology (AIT) Prognostics and diagnostics Total asset visibility

Table 5-1 has several areas of emphasis:

- ◆ Connectivity and bandwidth, including satellites
- ◆ System integration, including middleware
- ◆ Rules-based logistics processes and decision-support systems
- ◆ Security
- ◆ Systems assurance, including real-time data access
- ◆ Links to suppliers, including portals, exchanges, and Web-based planning
- ◆ ASPs
- ◆ Asset visibility, including AIT
- ◆ Prognostics and diagnostics.

On the basis of our analysis in Chapter 4, we believe that there is likely alignment in the areas of connectivity and bandwidth, rules-based processes (intelligent agents and bots), security, systems assurance, and asset visibility. We see potential misalignment in the areas of integrated systems, links to suppliers, ASPs, and prognostics and diagnostics.

Areas of Opportunity

Common protocols represent a key enabler of successful systems integration. Although common protocols are a significant issue within DoD, middleware is likely to be the solution to the systems integration gap. There appears to be a high potential for inclusion of middleware in Department initiatives; nonetheless, there should be a concentrated effort to monitor the pace with which the Services and agencies embrace this technology. Without its adoption, DoD will be unable to achieve the systems integration that is fundamental to its future plans.

Supplier portals allow partners in a supply chain to access a single Web site and obtain relevant information to support decision making. They facilitate real-time simultaneous processing that can help minimize cycle times. DoD is currently focusing on internal integration. It will not fully realize the operational abilities that its guiding documents outline, however, without external integration with its suppliers. Only with close, collaborative supplier arrangements can the Department achieve the most efficient supply, maintenance, and transport of items into and out of its system.

In their current state, ASPs may be too new for DoD to embrace without reservation. It may make sense, however, for the Department to execute a pilot with an ASP provider for a common application such as Microsoft Office. Alternatively,

to alleviate security concerns, it may make more sense for the Department to test the concept's viability by designating a particular internal organization as the ASP provider that offers software rental to other internal entities. With the Services and agencies beginning to accelerate their efforts with ERP systems, there may be an opportunity for an internal ASP to host ERP applications within the Department. An arrangement like this has the potential for significant cost avoidance as well as the benefits that accrue from a central system manager and knowledge repository.

While the Department's product support pilots will make use of advanced prognostics and diagnostics for new weapon systems, there is an apparent lack of focus on these technologies for deployed and aging weapon systems. The Department should establish a program to provide a comparable level of attention to existing systems. Incorporating real-time monitoring will improve the Department's ability to provide reliability-centered maintenance and performance-based support for fielded weapon systems.

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY

The Defense Advanced Research Projects Agency's (DARPA) involvement with DoD logistics began after the promulgation of Joint Vision 2010. DARPA is conducting research into technologies that support some of the gap areas that this report identifies. Two of these research efforts are the ALP and Ultra*Log.

Advanced Logistics Project

During 1996, DARPA initiated research—the ALP—to support Joint Vision 2010's focused logistics operational capability. The project may be regarded as removing the stovepipe information architecture of DoD and replacing it with an interrelated network of DoD agencies that share information. To automate sharing of information as much as possible, the ALP is studying an architecture of distributed heterogeneous agents that interact with each other seamlessly.

Ultra*Log

The Ultra*Log project is a supplement to the ALP. The ALP developed a cognitive agent architecture (Cougaar) to support a network of distributed agents. DARPA proved that Cougaar was effective during peacetime conditions; Ultra*Log will test the architecture under hostile conditions. Ultimately, Cougaar will be an architecture that can operate with up to 45 percent information infrastructure loss, in an environment that is 90 percent as chaotic as the most real-world environment, with not more than 20 percent capabilities degradation and not more than 30 percent performance degradation for up to 180 days of sustained military operations.

DoD should work closely with DARPA on these projects because their results could bridge some of the gaps identified in this report and dramatically improve logistics capabilities.

University of Maryland Recommendations

The University of Maryland's exploratory technology forecast offered several recommendations for DoD:

- ◆ A middleware and messaging strategy
- ◆ Greater use of portal applications and services
- ◆ A hosting capability within DoD
- ◆ Monitoring the impacts of portaling efforts on the supply base
- ◆ Strategies to diffuse technologies to all users.

The gap analysis with regard to common protocols, supplier portals, and ASPs supports the first three recommendations. Collaborative relationships with key suppliers are natural extensions of supplier portals. Collaborative relationships focus on information sharing more than on price, although price certainly is an element. For collaborative relationships to thrive, an organization's suppliers must stay in business. Executed correctly, portaling will not have a negative impact on key suppliers, although monitoring these relationships is an inherent responsibility for DoD.

The University of Maryland's report states that "as a network expands it becomes exponentially more valuable to each and every user."¹ With DoD's emphasis on integration, widespread distribution of technology becomes critical. As one organization adopts an advanced technology to improve its capabilities, it may distinguish its abilities from those of its peers and negatively affect its ability to integrate with them. We therefore agree with the University of Maryland's recommendation that the Department should establish a strategy to diffuse technology to appropriate users.

SUMMARY

Although technology does not generally appear to be the centerpiece of current DoD logistics initiatives (e.g., the names of DoD logistics initiatives do not contain the names of advanced technology), the initiatives generally seem to be enabled by the technologies of the exploratory technology forecast. Alignment is likely in the areas of connectivity and bandwidth, rules-based processing

¹ Sandor Boyson and Thomas Corsi, *The Year 2010 Netcentric Supply Chain: An Exploratory Technology Forecast*, University of Maryland, May 2000, p. 17.

(intelligent agents and bots), security, systems assurance, and asset visibility. There is potential misalignment in the areas of integrated systems, links to suppliers, ASPs, and fully integrated prognostics and diagnostics.

DoD will have to monitor the pace at which the Services and agencies embrace middleware and supplier portals; as it expands the use of portals, DoD must prevent erosion of supplier relationships. The Department also should attempt a pilot with an ASP for a common application or test the concept's viability by designating a particular internal organization as an ASP. It also should establish a program to aggressively promote the incorporation of prognostics and diagnostics into fielded weapon systems. In addition, it should develop a strategy for technology diffusion to further facilitate the integration it requires. Finally, DoD should continue to work closely with DARPA on the ALP and Ultra*Log.

DoD may be pursuing logistics initiatives other than those reported in the Best Commercial Practices 1999 Report to Congress, the POM Tab N-4s and Tab Gs, and the DRID 54 responses. We did not assess logistics plans that the Services, USTRANSCOM, and the DLA did not include in these official documents. Experience indicates that initiatives listed in internal planning documents but not submitted to OSD and Congress usually are not implemented. Improvements in reporting logistics initiatives in the Planning, Programming and Budgeting System and other processes may be necessary to obtain the most accurate picture of the technology implications of planned logistics initiatives.

Appendix A

The Year 2010 Netcentric Supply Chain: An Exploratory Technology Forecast

As part of this study, Sandor Boyson and Thomas Corsi—directors of the Supply Chain Management Center at the Robert H. Smith School of Business, University of Maryland, College Park—prepared an exploratory technology forecast. In their forecast, they discuss the technology that will be available in 2010 to support logistics processes. We used their forecast as a target for our study. In this appendix, we reprint their forecast in its original form.

The Year 2010 Netcentric Supply Chain: An Exploratory Technology Forecast

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Section 1 Executive Summary

The Office of Secretary Of Defense is looking out to the year 2010, trying to divine the shape of supply chains to come. This report, based on substantial research conducted by the Supply Chain Management Center of the Robert H Smith School of Business, serves to support that effort and to provide a structured analysis of the technology trends that could strongly influence the shape of supply chains to come. In consultation with some of the leading technology companies in the world, our team of researchers has developed and put forward a set of concepts related to the year 2010 Netcentric Supply Chain.

This futuristic supply chain will be fundamentally shaped by four major technology trends:

A. Accelerating connectivity across greater geographic swathes and massive broadband networks converging voice and data coming on-stream.

Companies like Global Crossing and Qwest are spearheading the change to digital networks enabling this convergence. Massive investments in fiber and satellite infrastructure capacities are leading to the doubling of speed of communications every three to six months (a forecasting rule known as Metcalfe's Law).

In addition to increases in speed of communication, sheer volume of bandwidth is increasing exponentially. For example, transatlantic **fiber capacity** expanded ten times between 1998 and 2000. Currently, we are verging on a bandwidth glut in key economic corridors. 360networks expects to have laid 56,000 miles of fiber on three continents within the year. Global Crossing is installing 97,000 miles of fiber on five continents; and Qwest is building a fiber optic network of 48,000 miles. It is estimated that only 6.5% of installed fiber in the U.S. is presently even "lit" and used; the rest is dark fiber awaiting higher demand.¹

This burgeoning availability of bandwidth is reflected in long distance telecommunications charges to corporate customers. The price of a call minute from the U.S. to Israel dropped from 32 cents to 8 cents over past three years.

The technological environment for the year 2010 will be marked by massive bandwidth availability across the entire globe. In addition to fiber networks traversing the major economic corridors, low orbiting satellites, provided by companies like Teledesic, will offer wireless Internet access anytime and anywhere at speeds up to one thousand times present day modems. Core engineering obstacles to high speed Internet satellite delivery are rapidly being removed. For example, services such as Direct PC, the Hughes Network offering could only offer digital data downloads off the satellite and used regular land phone lines for uploads. Recently, a Microsoft/Gilead Inc. partnership announced a technology for uploading data digitally via satellite, significantly bolstering the transfer rates and freeing users from the need to be tethered to land phone lines.

¹ Wall Street Journal, "Some See Fiber-Capacity Glut", Thursday, March 23,2000, page B6.

Despite this emerging global massive bandwidth availability, constraints to fully exploit the bandwidth resource will probably not be completely eliminated. These constraints will likely include:

- Nation-state and bureaucratic interference with the user-community, with gateway access to bandwidth still subject to control and excessive rents by totalitarian or corrupt state telecommunications authorities. The idealistic notion of the early 1990s that information wants to run free will remain just that- an idealistic notion- well into the future.
- Persistent last mile problems, with the firehose of bandwidth meeting a needle-size lumen of connector devices. The military today, with massive global bandwidth availability under mega-outsourcing contracts with telecommunications giants like AT&T, still has to strip away graphics from Power Point presentations when relaying data files to submarines at sea because of antennae limitations. Imagine the situation if the military truly informatizes itself and total situation awareness infiltrates every aspect of operations. If present trends continue, the likelihood of crippling data jams or- worse (i.e., dangerous stripping away of crucial data to achieve some modicum of network throughput will be omni-present).

B. The Transition To Smart Networks

We are witnessing the transition of software applications moving from separate packaged software bought and installed on local machines and internal corporate networks to integrated suites of applications, managed remotely by 3rd party applications service providers.

ASP providers, such as Digex, US Internetworking, Corio, Exodus and MSIA, are leading the conversion of software to hosted applications. These ASPs replace the customer's IT infrastructure with the transfer of any applications and data onto the ASP servers. All that is left on the customer's site are the desktop PCs or terminals, connected onto a phone line or Internet connection. Typically, the ASP will provide 24X7 customer support and ongoing system/ software upgrades, with charges based on the number of concurrent users and the amount of use by each user. For example, Corio will charge a daily user between \$595 and \$895 month to access hosted applications over a wide area network; whereas an occasional user accessing applications over the Internet would cost only about \$20 month.

Software providers, such as SAP, People Soft, and Oracle are already hosting ERP modules remotely via ASPs. For example, USI's suite of Internet-managed applications include: financial management and human resources management software, powered by PeopleSoft; customer relationship management powered by Siebel Systems; and electronic Commerce, powered by BroadVision and Microsoft.

The telecommunications providers, whose bandwidth carries the data and supports the ASP networks and user-communities, are positioning themselves to be part of this revolution in computing and Internet--based services.

Qwest signed a \$500 million deal with Hewlett Packard to equip Qwest's CyberCenters with hardware and software to support the carrier's forthcoming SAP/ERP outsourced service. On June 28, 1999, Qwest launched CyberSolutions, a joint venture with KPMG to develop application service provider hosting and management services for software such as ERP and Microsoft BackOffice Applications.

GTE has collaborated with the Sun-Netscape Alliance to create its Network Commerce Platform, which the company bills as a "web-based application rental platform for any hosted application." It will be operating system and application neutral with security features including digital certificates and user authentication.

Currently, we see other major telecommunications players, such as AT&T and Cisco, directly entering into alliances with application service providers such as Digex and USInternetworking.

These telecom players are attempting to absorb software hosting services right into their networks, a transitional phase on the way to smart networks with on-demand intelligence and functionality. Other companies, such as Lucent, envision networks becoming "application switches" that enable users to source and use specific software functionalities from different ASPs on an as-needed basis. Thus, the smart network will sense when one ASP's application servers are reaching overload and will automatically roll users over to another ASP's application servers that have available capacity. A variant on this vision is extending the operation system and applications of one server via real time global satellite linkage to other servers in the same corporate network on the other side of the globe and body snatching remote server capacity. This variant is currently under research by a Motorola/Sun partnership.

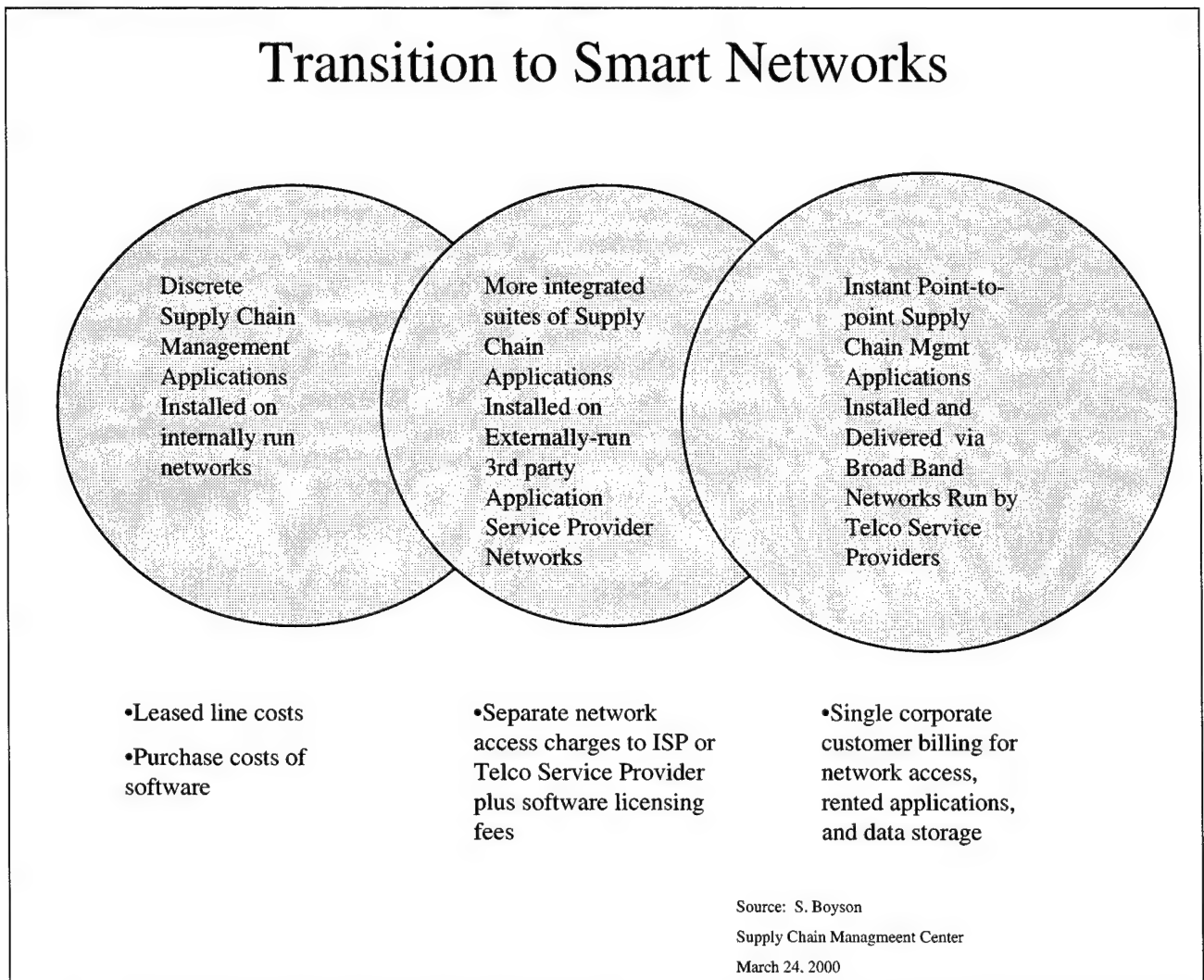
This overall transition will continue so that by 2010, there will be smart global networks with so much bandwidth availability that instant point to point connections can be established anywhere on the network and the delivery of as-needed, customized data/and applications can be sped to users.

The direction and phasing of this transition is shown in the following figures:

Figure 1. Evolution of Software

Evolution of Supply Chain Management Software			
	Phase I (1995-2000)	Phase II (2000-2005)	Phase III (2005-2010)
Leading Software Models	<ul style="list-style-type: none"> • ERP • Supply Chain Execution (Warehouse Mgt, Transportation Mgt, Etc.) 	<ul style="list-style-type: none"> • Collaborative Planning/Forecasting • Real-time Messaging Systems 	<ul style="list-style-type: none"> • "Smart Networks," very high bandwidth self-adjusting networks • Point to point delivery of customized Supply Chain applications over smart networks
Characteristics	<ul style="list-style-type: none"> • Large source code • Bulky applications designed to run on corporate networks • Internal Data Center-Managed applications • Focus on corporate transactions 	<ul style="list-style-type: none"> • Lighter, faster applications designed for Web • Streamlined, automated set of business rules with exception/event reporting to key decision makers across the network • Shift to suites of Supply Chain applications hosted by 3rd party application service providers: (ASPs) • Focus on joint operational agility between companies in a shared supply chain 	<ul style="list-style-type: none"> • Bandwidth & applications bundled together by network providers • Real time total supply chain visualization from assets in the field to key external events • On demand Supply Chain applications customized for individual users • Mergers of ASPs into Telco Network Providers • Virtual Supply Chains, reconfigurable on the fly

Figure 2. Transition to Smart Networks



There are enormous challenges to reaching this vision of smart networks. Domain support, sustaining 200 millisecond transactions from a network perspective, remains a significant hurdle; as does tracking and reporting different levels of licensed software services usage. But a concerted effort is underway to solve these issues.

For example, Cisco has pulled together an ASP “ecosystem” of some 127 technology companies, ranging from companies that provide web hosting services, such as MSIA, to companies, such as Xevo, that have developed intelligent agents that migrate to desktops and monitor use of rented software over the net.

In addition, Cisco is even reengineering its core product, IP routers, for the future smart networks. Cisco is now embedding Tibco, Inc.’s middleware and real time messaging/publish and subscribe technology into its new generation of intelligent routers. Eventually, these routers will become business message traffic cops, extracting real time

data from heterogeneous databases and dynamically addressing vital business data and messages to corporate users across the network.

Such innovations can extend computing power and can offload complexity from in-house corporate managers and management systems to outsourcing specialists. Nevertheless, the dangers of these innovations are also obvious, including the possible subversion of mission critical hosted servers by hackers intent on mischief or terrorism. One can envision a scenario where hosted systems become slave systems under the control of intruders for short or extended periods.

C. Real Time Total Asset Visibility

The ability to link and to effectively monitor, in real or near real time, disparate remote assets and devices of all kinds, from inventory in transit to sensor devices out on remote grids, is on the horizon and achievable by the year 2010. This ability will flow from the following developments:

- **Spread of protocols for pervasive device inter-communication and networking**, such as Sun Microsystem's Jini, which enables a device to register itself on a network and update its location and systems status in real time and Intel's Bluetooth, which enables disparate wireless devices to communicate.
- **Spread of standards for industry-wide transactions processing**, such as RossetaNet's XML consortium for the electronics industry or the Data Interchange Standards Association's XML consortium for the financial industry.
- Rise of new, integrated operating platforms for electronic processes, such as proposed in IBM's Supply Chain Development Initiative.
- **Rise of more reliable and cheaper radio frequency tags, I- buttons and other field sensors**. For example, Dallas Semiconductor produces thermocron I-button devices today that attach to shipments of fresh produce and seafood. These devices take constant temperature readings to assess shipment safety and can be scanned and read by handheld devices.

Taken together, these spreading protocols, standards, new operating platforms, and sensor technology will enable an organization to track and monitor highly distributed assets in real time; to rapidly reconfigure and deploy joint assets with extended enterprise partners; and to conduct global transactions with less "friction," e.g., less cost and time delays.

Yet, it would be wrong to imagine this type of visibility as a process that will unfold in some automated or semi-automated fashion or as the result of one dominant standard or platform that will ultimately prevail. Visibility will more likely flow from a series of highly labor intensive efforts to tag and inventory assets in the field and to connect them together (actually to cobble them together is the more appropriate description of what

will happen) with whatever evolving technologies seem most reliable at the time. Visibility in the year 2010 will probably seem as hard won as it does today, even with access to more advanced technologies.

D. The Emergence Of The More Integrated Supply Chain Business Model: The "Glass Pipeline" Model

Further integration will occur as customer-order self-service portals; web-enabled "demand-driven" production and inventory replenishment processes; distributor/supplier collaborative planning/forecasting efforts, and online purchasing/marketplace exchanges, all come together into more seamlessly inter-woven supply chains.

Today we are seeing only the very beginnings of such integration. Take Cisco Systems as an example of early success in supply chain integration. Cisco has used the Internet to lower its cost of doing business more than \$560 million per year, while growing at an annual rate of 400 percent for the past five years. How has it done this?

It now receives more than 50% of its product orders via the Internet. Its customers use 24-hour web based applications to price, configure, validate, and order products. By automatically trapping errors at the configuration stage, Cisco has reduced orders that require reworking from 15% to 2%. On the supply side, Cisco's e-commerce applications automatically notify a group of suppliers when incoming orders deviate from forecasts. By increasing responsiveness to customers, Cisco has been able to improve revenue capture by \$100 million annually. By integrating suppliers earlier in the ordering process, the company has reduced lead times from an average of 40 days to 7-21 days.²

Cisco has had to cobble together functionality and best of breed technology applications from providers such as Ariba and Extensity in order to attain their pipeline flow. Soon more integrated application sets will be available. Oracle recently unveiled its web-rewritten integrated ERP system 11 I which is a first attempt to put a whole intermeshed suite of supply chain applications on the web.

But integrated web-based supply chains are not only internally managed, as in the case of Cisco. Hosted application suites, such as the Pandesic suite hosted by Digex, represent early attempts to migrate supply chain wide management to the web as an outsourced service.

Yet there are counter-forces that could come into play and blunt the impact of the advances in integration outlined above. Senior management resistance to abandoning sunk investments in earlier vintage technology; enterprise culture constraints to info-sharing are examples of counter-forces that could blunt or delay diffusion of new supply chain technology integration.

There are also less obvious counter-forces, such as regulatory impediments. For example, on March 22, 2000, news media reported that the Justice Department has initiated a probe of the AutoXchange, an online marketplace where the major automakers are combining

² Cisco Systems, "Building A Global Networked Business", January, 2000

their purchasing power (a combined annual buy of \$280 billion) to gain volume discounts from suppliers. This probe centers on possible cross-company buy-side collusion to fix prices, the reverse of seller side monopoly price gouging. Adverse legal rulings could limit the spread of such e-supply chain exchanges.

The recent announcement by four major defense contractors including Boeing and Raytheon of a Defense Procurement Xchange with CommerceOne also must raise other fears. In the search for scale purchasing economies will these contractors inadvertently lower supplier quality standards? Or will suppliers' profit margins be driven down to such unsustainable levels that the supplier base itself will be threatened? Will national security be the ultimate victim of Internet-enabled economic cartels on the buy side? Will strategic suppliers need special incentives and treatment to avoid extinction from short-term gain taking on the buy side?

E. Implications For DOD

Given the unpredictability and volatility of these scenarios, DOD must "hedge its bets" and attempt to "bulletproof" its supply chain technology strategy to the fullest extent possible. What is the short and medium term implication for DOD of the technology trends and counter-trends cited above?

First, in the transitional period to completely inter-operable networks and applications, DOD supply chain planners still require a middleware and real time messaging strategy capable of extracting from and linking disparate legacy, ERP, Internet and other data sources across DOD and its extended enterprise partners.

Second, DOD should be seeking to portal supply chain applications and services in a far more comprehensive manner than hitherto attempted. It needs to migrate to an architecture of centrally managed servers and much thinner, more pervasive clients to gain greater situational awareness and distributed real time computing. **This means the Office of Secretary Of Defense itself needs to establish a shared supply chain application service provider capability to support the joint forces in a leveraged and efficient manner; to distribute new supply chain technology upgrades instantly across the network; and to maintain a single DOD-wide supply chain deployment visibility.**

DOD should be expanding discussions with global telecom providers and application service providers to ensure the availability of suites of hosted supply chain applications needed for its own distributed transactions. DOD as the lead investor in the Internet needs to develop a similar pattern of influence over the next-generation Omninet, the smart ubiquitous service-based network that will rapidly emerge over the next decade. Joint R&D and other collaborations with global providers such as Lucent, Cisco, AT&T and with major ASPs, such as Digex, USI, and Exodus, should be initiated by DOD.

Thirdly, while pursuing centralized portaling and hosting strategies, DOD must simultaneously focus on a massive diffusion strategy to the services that will enable the

easing of the last mile constraints. Two way digital, satellite-based Internet connectivity is one tool that can be employed in this strategy.

Fourthly, while actively pursuing extended enterprise activities and while linking to a range of industry or commodity-specific procurement portals to benefit from scale efficiencies in purchasing, DOD must nevertheless monitor the negative impacts of such activities on core suppliers to avoid endangering the critical supply base in pursuit of short term operational gains.

Section 2 The Year 2010 Netcentric Supply Chain: An Exploratory Technology Forecast

A. Introduction

This exploratory forecast is being undertaken in response to the need of the Office of Secretary Of Defense to predict the direction and velocity of technical change in supply chain management. These changes have important strategic implications for readiness and joint force capability, and significant- indeed critical-capital and skill requirements.

The authors, co-directors of Supply Chain Management Center of the R.H. Smith School, herein outline an approach to the conduct of a rapid, preliminary forecast in support of the Logistics Management Institute's major study collaboration with OSD.

B. Study Approach

What is technology forecasting? The term technology forecasting actually covers two different but complementary corporate /organizational activities.

- Technology Surveillance. Corporate surveillance programs are based on the premise that close observations of "precursor" events, trends and influences will allow accurate and effective corporate competitive strategy and investment responses to technological change. Surveillance programming typically has three levels:
 - scanning, which is like a radar system seeking to find blips of key information on a wide horizon;
 - monitoring, which selectively follows up on technical development areas identified by scanning; and
 - tracking, which is the most intensive of surveillance techniques and declares "code red" in terms of corporate responses to new products or processes nearing introduction that represent major threats or opportunities.
- Technology Forecasting, which is more long term and far-reaching in its time dimension. Various forecasting techniques can be used and grouped around these themes:
 - **extrapolative techniques**, such as trend analyses, attempt to understand the directions and rate of technical change in the past and project into the future based on these findings.
 - **log-linear trending**, such as Moore's law which has accurately predicted the doubling of packing density of chips every eighteen months.

- **Normative Techniques**, such as impact wheel analysis or delphi group analysis, which are highly structured reasoning procedures for predicting the future and attempting to anticipate as many contingencies and discontinuities as possible. For example, impact wheels attempt to lay out and map the first, second and higher order effects of a given event, e.g., wireless phone service becomes cheaper than fixed phone line service. This could immediately displace most phone booths in urban areas as a first order effect.

The findings of tech forecasting literature consistently say the following:

- There are no perfect forecasts
- There is no best method; it depends on type of data, forecast horizon and error criterion.
- Simple methods work well, with the overriding themes being fancy=fragile and simple=robust.
- Combining results usually helps, with dissimilar approaches best to assure spread of coverage of a complex topic.

For the purposes of this exploratory forecast, we will be conducting and combining both trend analyses and normative expert judgement interviews/exercises in order to conduct a technology forecast for the Year 2010 Netcentric Supply Chain. Trend analyses will be studied and both historical and projective analyses through literature reviews and log-linear relationships will be defined and explored.

The content of the forecast will seek to address the following:

Which will be the core technologies of the netcentric supply chain in the year 2010?

We will attempt to describe a portfolio of critical technologies: IT architectures, hardware / software systems, and applications that will be used to manage global real time supply chains in the year 2010. We will briefly outline future requirements for IT capabilities/ connectivity and highlight critical software choices, issues, and challenges.

How might netcentric supply chains in the Year 2010 be organized and operated?

We will attempt to describe how a prototype organization over the next decade might radically improve its supply chain utilizing the technologies we identified above. We will try to address what is the shape of the future supply chain organization; what supply chain leaders will have to do; and what the new skill sets are that will be required to do them. We will highlight the critical few

management practices and business processes that will be required over the next decade to complement changing supply chain technologies.

Section 3 Technology Overview

A. Introduction

This section provides an overview of recent and emerging technologies that will have a profound impact on supply chain management in the year 2010 and beyond. The discussion centers on developments in the following areas: connectivity; computer hardware; computer software; system architecture; and artificial intelligence. The section concludes by examining the extent to which these technology enhancements will facilitate rapid growth in both business to business and business to consumer e-commerce transactions.

Section 4 of this report examines how supply chain management will be incorporating the suite of new technologies to improve and enhance supply chain efficiencies. The section highlights tremendous changes in the technology of supply chain management as a consequence of the infusion of new technologies featured in Section 2. The report's Section 5 focuses on new business practices that will drive supply chain management in 2010 and beyond as a consequence of a new supply chain management technology. Section 6 discusses the implication of new business practices in a technology-driven supply chain for the military supply chain situation, with its host of unique concerns and issues.

B. Connectivity Developments

The topic of enhancements in connectivity can be divided into a discussion of the diffusion of a series of technologies recently introduced to the marketplace as well as a set of emerging and future technologies, less well-established at present. The recently introduced technologies include ISDN; satellite; cable; and DSL. All these technologies provide the user with higher speed connections to the Internet than are presently commonplace through modems connected to the telephone system. The emerging and future technologies include fiber optics; broadband satellites; wireless devices; and infrastructure improvements (Internet2 and beyond). Connectivity enhancements that are promised by these emerging and future technologies are even more dramatic than are the enhancements promised by the recently introduced technologies.

1. Recently-Introduced Technologies

ISDN. An integrated services digital network (ISDN) connection to the Internet can usually be obtained from a local telephone company, although availability and pricing vary around the country. Once in service, an ISDN connection can be treated like an additional phone line and used for making ordinary calls. For the Internet, the use of a special modem connects a computer to an ISDN line and the Internet at maximum speeds of 128 Kbps. An ISDN connection can be split into different channels, allowing access to the Net and use as a telephone at the same time.

Satellite. Another option to enhance connectivity speed is a small, 21-inch satellite dish. This service does exist as a commercial product and is accessible throughout most of the United States. The advantage of satellite-based Internet connections (400 Kbps maximum speed) is that there are few geographic limitations to their use. The dish is simply pointed at a defined angle and direction in order to target the service provider's orbiting satellite. Then, a card is installed in the PC that connects the dish to the computer. Satellite Internet connections are not cheap, since you need an ordinary telephone connection as well. A phone connection is also needed because the outgoing request is actually sent via the telephone line. In fact, all outgoing messages--including file transfers--must be done through the slower phone connection.

Cable. The same cable that delivers TV channels to homes can also deliver high-speed Internet connectivity. Speeds obtained by a cable modem connection are impressive and can theoretically reach 10 Mbps. Cable modems use co-axial cables to transmit data. The effective download speed is between 1.5 to 3 Mbps, rivaling the speed from T1 lines. The speed for uploading documents is usually less than that. The major drawback of cable modems is their lack of availability. Many areas are not yet wired with the fiber optic network required to run cable modems. While speed will be less depending on how many multiple users are configured in your neighborhood, cable modems provide the fastest Internet access in the home setting. A cable modem may even be faster than the access scientists have in their university labs

DSL. The digital subscriber line is a service that is provided by a local telephone company. With maximum speeds at about 8 Mbps, a DSL line is similar to a cable modem. DSL uses conventional copper phone lines. There are several DSL variations: high-bit-rate DSL (HDSL), symmetric or single-line high-bit-rate DSL (SDSL), very high-bit-rate DSL (VDSL), dedicated ISDL DSL (IDSL), and asymmetric DSL (ADSL). Set-up fees and modem charges can total \$1000 and monthly charges are about \$100 per month at the moment and fees are falling quite rapidly. Like cable connections, a DSL line is always live on the Internet. DSL service is geographically limited and can be expensive to set up, but this technology has the potential for widespread use.

2. Emerging and Future Technology Enhancements

Fiber Optics. Optical fiber (or "fiber optics") refers to the medium and the technology associated with the transmission of information as light pulses along a glass or plastic wire or fiber. Optical fiber carries much more information than conventional copper wire and is in general not subject to electromagnetic interference and the need to retransmit signals. Most telephone company long-distance lines are now of optical fiber. Transmission on optical fiber wire requires repeating at distance intervals. The glass fiber requires more protection within an outer cable than copper. For these reasons and because the installation of any new wiring is labor-intensive, few communities yet have optical fiber wires or cables from the phone company's branch office to local customers (known as local loop). Yet, this technology is coming to the house through its expanding use among cable TV operators, who have been updating their infrastructure to the fiber optic alternative. Introduction of the fiber optic technology by cable TV operators would allow for two-way data transfers from the home computer to the Internet. With existing co-axial

cable only data downloads occur at high speeds, data uploads use the modem connection to the ordinary telephone wire.

Broadband Satellites. A powerful new generation of broadband satellites will take to the skies, erasing the hard-number relationship between cost and distance and creating true universal service. These virtual switches in the sky promise to extend the information revolution to every corner of the globe. They will vastly reduce the time and cost needed to deploy new networks and services. Furthermore, they will offer enough capacity to handle the future's most exciting new applications. By seamlessly combining voice, video, and data using common packet-based (IP, frame, cell) network infrastructures, the cost and complexity of maintaining networks will be dramatically reduced. This integrated approach will eventually deliver anytime, anywhere communications capabilities worldwide. Satellite-based service is the most advanced and the most risky--from both a technical and an investment perspective.

Most existing communications satellites are geosynchronous. This means they are at exactly the right height above the earth so that they orbit at exactly the same rate as the earth turns. The result is that they are fixed in the sky with respect to a receiver on the earth. Thus, home satellite dishes for receiving TV signals don't have to move to track the satellite. Yet geosynchronous satellites have several drawbacks. They are a long way up (about 36,000 kilometers), so there is a delay in sending a signal up and back. This delay degrades many forms of data transmission. The distance also means that the satellite must have a powerful transmitter or transmit at a low data rate.

While today's broadband access market consists of less than one million subscribers, industry experts expect more than 1.87 million broadband access service subscribers worldwide within the next six years. Beginning in 2001, a new class of broadband Ka-band (18 GHz to 30 GHz) data satellites may offer global coverage, expanded bandwidth, and limited processing capabilities. The Ka-band holds great promise because it provides additional spectrum and has the ability to support broadband data provisioned to small and cost-effective ground antennas. Next generation broadband satellite networks may introduce advanced switching and processing capabilities to the orbiting platform itself.

3. Wireless

Local multi-point distribution services (LMDS), which is receiving a lot of attention from access providers, use a radio signal of very high frequency (28 gigahertz). The basic premise behind wireless networks is that the major cost of installing any broadband system based on wire or fiber is not the cable itself but the labor to install it. Thus, wireless networks eschew wire lines. Instead, like cellular telephones, these networks use radio connections from a base station antenna to remote units at residences. Engineers are developing a number of configurations, which can be categorized by the distance between base stations, the data transmission rate, and issues such as whether the remote units can be mobile.

One wireless system for data is designed to use the existing cellular telephone towers and thus must operate using the spacing of those facilities. So far these systems offer only

modest data rates (10 to 50 kbps) and are marketed to users on the move, not for residential access. Still, the cellular industry has plans for more aggressive use of its towers, to deploy services with data rates up to 1 Mbps to the home. Commercial service is expected in a few years.

Consumers must be aware of standards, or the lack thereof, in wireless LAN technology. Ratified in the summer of 1997 by the Institute of Electrical and Electronics Engineers (IEEE), the original 802.11c standard for 2.4GHz wireless networks has done little to promote interoperability among products from competing vendors. The main problem, said wireless experts, is that the 802.11 standard is not really a standard. It allows for both frequency-hopping and direct-sequence-based radios, two incompatible technologies. Also, due to low data rates (2 Mbits or less), wireless applications have been relegated to vertical niches such as warehousing, retail, and manufacturing. "The wireless LAN industry has always been held back to a large degree from entering into a broad-based general-purpose marketplace because the data rates were significantly slower than Ethernet rates," said Mack Sullivan, director of the Wireless LAN Alliance, a wireless industry trade organization. The 802.11 High Rate Direct Sequence, a new standard soon to be approved by the IEEE, promises to change this by offering a single, 1-Mbit standard. The higher data rate could bring wireless technology to broader markets.

4. Internet2 and Omninet

The Internet is being redesigned by a group of more than 120 U.S. universities with the goal of providing high bandwidth connections that can be used for research purposes. Internet2 will not replace the current Internet, but it will serve as a platform to achieve communications speeds that are 100 times faster than currently possible. Current demonstration projects have applied Internet2 technology to topics such as three-dimensional brain mapping, molecular modeling, microscopy, and virtual reality anatomy.³

The Internet, as we know it today, is being transformed into an Omninet, which will be a better wireless "communications web as intricate, powerful, and malleable as its living ancestors". It will be an intelligent, almost human-like presence that will web everything together. Researchers at large technology companies and universities are already working on this and, given the past trend growth of the Internet, there will be some form of the Omninet working in 2010.

A critical part to this Omninet is its use of smart dust that is under current development. A cubic inch-size prototype (a smart rock) is actually working now, however, researchers are trying to make it microscopic in size. This smart dust will have the ability to sense temperature, humidity, light, see with a camera, know its position through a GPS, and communicate its information wirelessly onto the Omninet. Some variation of this will definitely be available in 10 years!⁴

³ <http://www.internet2.edu/html/97engineering.html#>

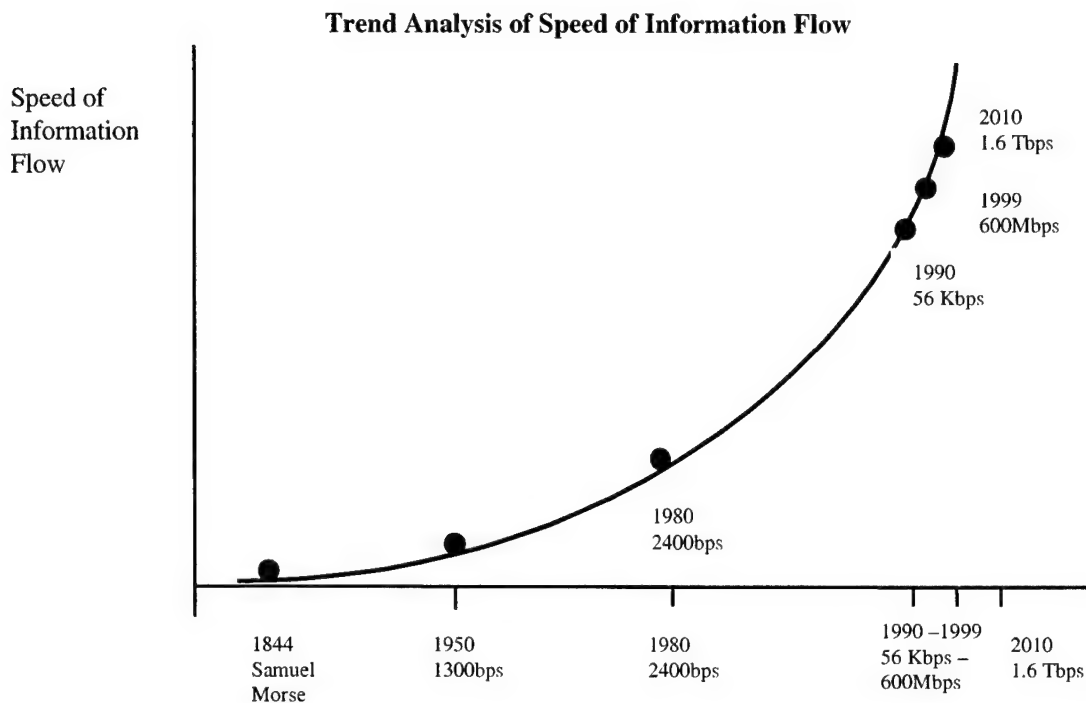
⁴ G. Johnson, "Only Connect from Swarms of Smart Dust to Secure Collaborative Zones, the Omninet Comes to You", *Wired*, January 2000.

5. Overall Impact

A May 1999 survey by Mercer Management Consulting in Washington, D.C. shows that people with high-speed access search for information and make purchases on-line at approximately double the rate of those with lower-speed analog modems. The survey was of roughly 1,000 users who access the Internet via cable modems. Those with high-speed access to the Internet are a minority now. But three forces are combining to accelerate broadband's replacement of narrowband: the price of a certain level of performance; response time; and network effects. Of course, lower prices have raised demand for almost all electronic services in the past. When America Online introduced flat rate pricing in December 1996, the on-line time per individual shot up; no longer charged on a per-minute basis, people would log on and stay on even while not using the Internet or checking e-mail. The process is not gradual: little happens until a threshold price is reached. Reaching this pricing threshold triggers a burst of new demand. Broadband now appears to be nearing its threshold, making it likely that we will soon see additional dramatic price performance improvements and consequent leaps in demand. Broadband will also create faster access and response time and further stimulate Internet uses. Simply stated, most people will not use the Internet frequently and for a wide variety of tasks until they have the high-speed and always-on characteristics of most broadband services.

Finally, and most important, as a network expands it becomes exponentially more valuable to each and every user. A physical mail or e-mail system that reaches 99 percent of addresses is far more than twice as useful as one that reaches 50 percent of addresses. Today's low-bandwidth computers and telephones connect users with one another but only in mildly useful interactions. However, as bandwidth expands, so to will the interactions among users.

Figure 3. Trend Analysis of Speed and Information Flow



As shown in Figure 3 (Trend Analysis of Speed of Information Flow), the next decade will see vast increases in the speed of information flow. As the decade of the 1990s began, the 56 Kbps modem was the industry standard. However, by the end of the nineties, with the introduction of Cable modems, that speed had risen significantly. By 2010, broadband technology will have become commonplace with 1.6Tbps becoming the new threshold.

C. Hardware Developments

Today microprocessors and memories are made in distinct manufacturing lines, but it need not be so. Perhaps in the near future, processors and memory will be merged onto a single chip, just as the microprocessor first merged the separate components of a processor onto a single chip. To narrow the processor-memory performance gap, to take advantage of parallel processing, to amortize the costs of the line and simply to make full use of the phenomenal number of transistors that can be placed on a single chip, the high-end microprocessor of 2020 will be an entire computer.

This new merged chip is IRAM, standing for intelligent random-access memory, since most of the transistors on this merged chip will be devoted to memory. Whereas current microprocessors rely on hundreds of wires to connect to external memory chips, IRAMs will need no more than computer network connections and a power plug. All input-output devices will be linked to them via networks. If they need more memory, they will get

more processing power as well, and vice versa--an arrangement that will keep the memory capacity and processor speed in balance.⁵

Today's microprocessors are almost 100,000 times faster than their Neanderthal ancestors of the 1950s. When inflation is considered, they cost 1,000 times less than did their ancestors. These extraordinary facts explain why computing plays such a large role in our world now. Looking ahead, microprocessor performance will easily keep doubling every 18 months through the turn of the century. After that, it is hard to bet against a curve that has outstripped all expectations. But it is plausible that we will see improvements in the next 25 years at least as large as those we have witnessed in the past 50 years. This estimate means that one desktop computer in 2020 will be as powerful as are all the computers in Silicon Valley today.

The future of display technology lies with Active Matrix Liquid Crystal Display (AMLCD).⁶ AMLCD is based on breakthrough research (at IBM) that allows the use of aluminum and copper instead of the metals traditionally used in displays, molybdenum and tungsten. Aluminum and copper are better conductors, and make low-cost, higher resolution possible. Users who need to view large volumes of complex data will benefit from 200 pixels-per-inch (ppi) high resolution and high-content displays. The new screens are expected to vastly improve digital libraries -- databases of scanned images such as those stored by hospitals or insurance companies -- and graphic design and electronic publishing applications. The new screens can display six times the information that can currently be shown on a conventional XGA monitor and will create a new market for LCDs. Industries that heavily rely on paper or film, such as radiology, medical, digital photography, and publishing, will be able to process information digitally without sacrificing data and image quality

D. Software Developments

Computers currently respond only to what interface designers call direct manipulation. Nothing happens unless a person gives commands from a keyboard, mouse, or touch screen. The computer is merely a passive entity waiting to execute specific, highly detailed instructions; it provides little help for complex tasks or for carrying out actions (such as searches for information) that may take an indefinite time. If untrained consumers are to employ future computers and networks effectively, direct manipulation will have to give way to some form of delegation. Researchers and software companies have set high hopes on so called software agents, which "know" users' interests and can act autonomously on their behalf. Instead of exercising complete control (and taking responsibility for every move the computer makes), people will be engaged in a cooperative process in which both human and computer agents initiate communication, monitor events, and perform tasks to meet a user's goals. This change in functionality will most likely go hand in hand with a change in the physical ways people interact with computers. Rather than manipulating a keyboard and mouse, people will speak to agents or gesture at things that need doing. In response, agents will appear as "living" entities on

⁵ <http://iram.cs.berkeley.edu/overview.html>

⁶ <http://www.research.ibm.com/topics/innovate/display/>

the screen, conveying their current state and behavior with animated facial expressions or body language rather than windows with text, graphs, and figures.

E. System Architecture

As the Web-hosted world expands, so, too, will the influence of an emerging group of players--the application service providers (ASPs)--which offer Web-hosted applications. These now include such services as managing disparate company databases and running and maintaining servers to provide e-mail to small companies that choose not to buy and install the necessary equipment.

With barriers between computer, telephone, and audio/video technologies tumbling down, high-speed data transmission, digital compression, multimedia, the Internet, and other technologies have become integral to communications network planning. In this changing landscape, facilities owners, managers, and designers must make difficult decisions about network investments and their cable infrastructures, knowing that decisions made today can have a financial impact for years to come. Product options include fiber-optic cable, coaxial cable, hybrid fiber coax, Category 5 cable, enhanced performance Category 5 cable, and a new patented design unshielded twisted pair (UTP) cable designed for multimedia transmission. Product selection considerations include the size and layout of the physical premises and a realistic assessment of present and future requirements.

Across all applications and at all levels, designers and end users, with extremely powerful CPUs at hand, are less concerned with the raw computing power of their systems than they are with getting more and more data into and out of a system at ever-increasing rates. The new design agenda not only figures in network-related servers, routers and bridges, and telecom environments, but also in many previously non-connected embedded environments. In servers, designers are finding that traditional solutions based on bus-based alternatives such as PCI and I²O are running out of steam, topping out at 300 to 500 Mbytes per second. The initial response is to devise extensions such as PCI-X, which will push throughput up to about 750 to 1,000 Mbytes/s. Fundamentally new architectures are also appearing. These include switching-fabric point-to-point alternatives such as Intel's NGIO and the Future I/O specifications, which push bandwidth all the way up to 1,000 Mbytes/s and beyond.

These predictions are in line with The Gartner Group study that predicts that by 2002, 80 percent of host access and terminal emulation will occur via browser or Java functionality, and the overall thin-client market will reach \$3 billion. The same study says that developers will target browser platforms and look for an important shift away from the Windows platform as architecture for client applications. Gartner projects that by next year, only 43 percent of developers will target Windows as their primary development platform, a sharp decline from 72 percent in 1997. By 2001, browsers will become the primary target for development.⁷

⁷ <http://www.networkcomputing.com/1013/1013f1side3.html>

F. Artificial Intelligence

Given the goal of doing more by doing less and the model of the Information Marketplace, how do we get there in practice? To that end, the MIT Laboratory for Computer Science launched a major research project expected to result in a radically new hardware and software system called Oxygen, which will be tailored to people and their applications and will become as pervasive as the air we breathe. This multimillion-dollar, five-year project involves some 30-faculty members from the Laboratory for Computer Science, working in collaboration with the Massachusetts Institute of Technology (M.I.T.)'s Artificial Intelligence Lab.

At the heart of the Oxygen system is the Handy 21, which is like a cellular phone, but has additionally a visual display, a camera, infrared detectors, and a computer built into it. The Handy 21 brings the help needed to where the user is. Moreover, it is all-software-configurable in that it can change at the flip of a bit (in any country) from a cell phone to a two-way radio talking to other Handy 21s, to a network node near a high-speed wireless office network, or to a plain FM radio.

The second key technology of Oxygen is the Enviro 21. Unlike the Handy, which follows people, this device stays attached to the environments around people. It is built into the walls of the owner's office and (his or her) house and into the trunk of that person's car. The Enviro 21 bears the same relation to the Handy 21 as does a power socket to a battery. It does everything the Handy 21 does but with greater capacity and speed. Enviro 21s may also be set up to regulate all kinds of devices and appliances, including sensors, controllers, phones, fax machines, and arrays of cameras or microphones.

Oxygen interacts with the inanimate physical world in two ways--through these controllable appliances and through the infrared detectors in the Handy 21s. If a door is of interest to a person's machines, (he or she) pastes an infrared tag on it. Thereafter, when people point their Handy 21s to that door, the machines read the identity of the door and show what is supposed to be behind it. In other words, the system provides a kind of x-ray vision, helping people relate to the physical objects of interest in their environment.

The Handy 21s and Enviro 21s will be linked by way of a novel network, Net 21. Its principal function is to create a secure "collaborative" region among Oxygen users who wish to get together, wherever they may be. The Net 21 must do so on top of

the noisy and huge Internet. It must be able to handle constant change as aggregates of participating nodes rise and collapse. It must find you wherever you are. It must connect to numerous appliances. And it must connect to the world's networks. This is no easy task. Oxygen will require a radically new approach to networking protocols that draws on self-organization and adaptation and that augments today's Internet.

Oxygen must also involve perceptual resources, especially speech understanding, and address people's inherent need to communicate naturally: we are not born with keyboard and mouse sockets but rather with mouths, ears, and eyes. In Oxygen, speech

understanding is built-in--and all parts of the system and all the applications will use speech.

Oxygen's fifth technology deals with people's need to find useful information. Oxygen is being designed so that the user can first check (his or her) own knowledge stores in ways that are familiar to (him or her). The system will allow the user to say simply, "Get me the big red document that came a month ago," forgoing reference numbers and other clues. Oxygen will also check the stores of friends and associates who agree to share their knowledge with the user, in the same sense that a user might ask a friend or a co-worker a question if (he or she) doesn't know the answer. Finally, Oxygen will search the vast information stores on the Web and "triangulate," relating what it finds there to the user and (his or her) associate's stored knowledge bases.

Oxygen will also let people off-load routine and repetitive work onto their electronic bulldozers. It will help users write scripts for automating various jobs, as well as monitor and control the many appliances connected to the Enviro 21s. "Turn up the heat." "Print it there." "Every day at noon, give me the price of my portfolio and the weather in Athens." "Oxygen will take care of such instructions using a reason and control loop, which allows a person to guide the machine gently as it carries out automated tasks.

The system's collaboration technology will help people keep track of what they do as they move forward. For instance, the system will keep a hyperlinked summary of a meeting, provided by a human secretary, with the help of speech-understanding annotations. When the user asks what was decided about, say, a new building's glass roof, it will give the user the secretary's three-word summary--"We eliminated it." If, however, the user wishes, it will also let (him or her) probe deeper into the chain of spoken and video input that led up to that conclusion.

Last, Oxygen will include customization technology that tailors information to individual needs. There will be no shrink-wrapped software. All software will be downloaded onto the Handy 21s and Enviro 21s from the Net 21 network, triggered by user requests, errors or upgrades. The customization technology will also let people adapt the machines around them to their own needs and habits throughout their use of the other Oxygen technologies. Oxygen, then, is an integrated collection of eight new technologies: handhelds, wall and trunk computers, a novel net, built-in speech understanding, knowledge access, collaboration, automation, and customization. The power of Oxygen lies not in any one piece but in the totality of these human-oriented technologies together.

The five technologies of speech (and other perceptual capabilities), knowledge access, automation, collaboration, and customization are the only new kids on the block. These five are the foundations on which any new activities that help us do more by doing less will be built.⁸

⁸ <http://www.lcs.mit.edu/anniv/press/oxygen040799>

Figure 4. U.S. Population and Internet User Projections⁹ & ¹⁰

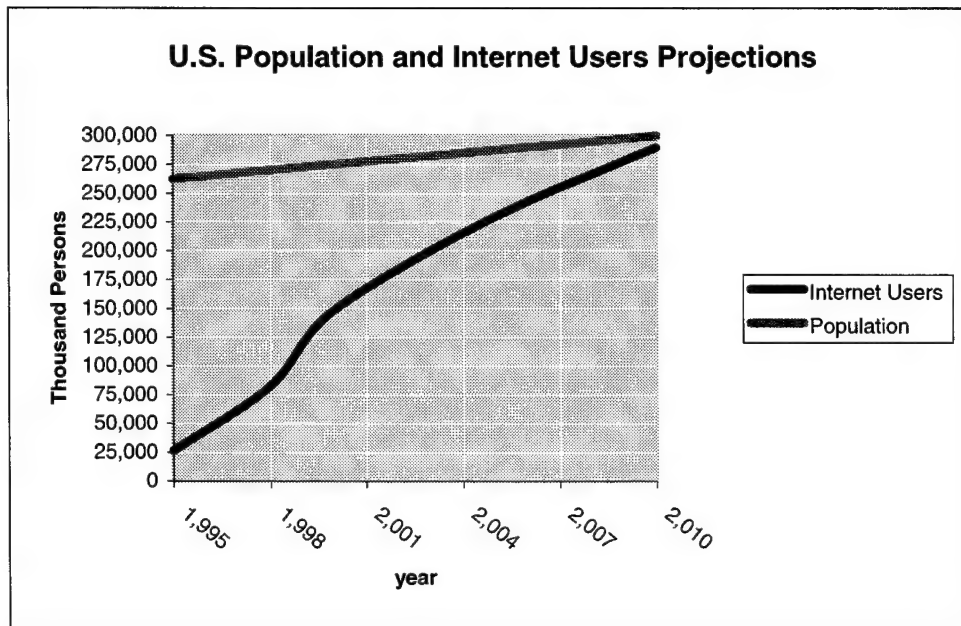
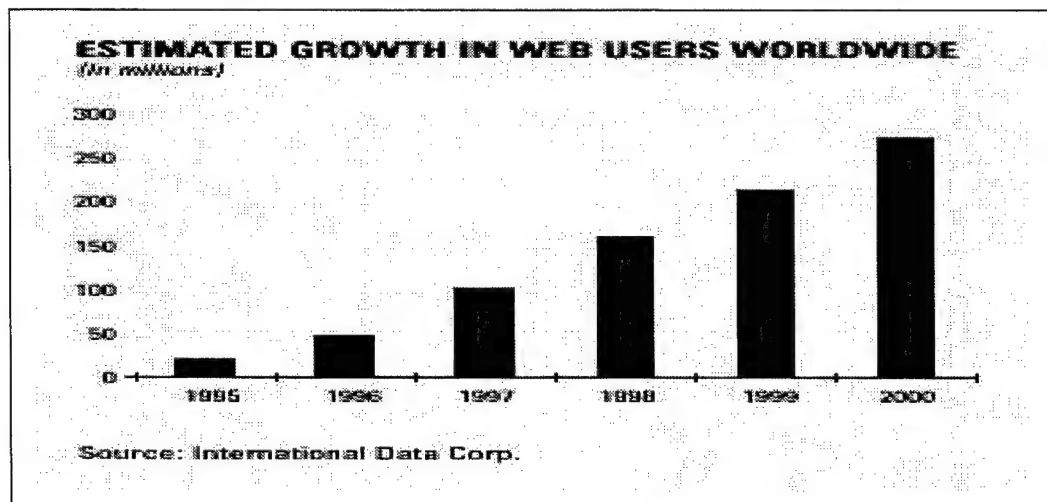


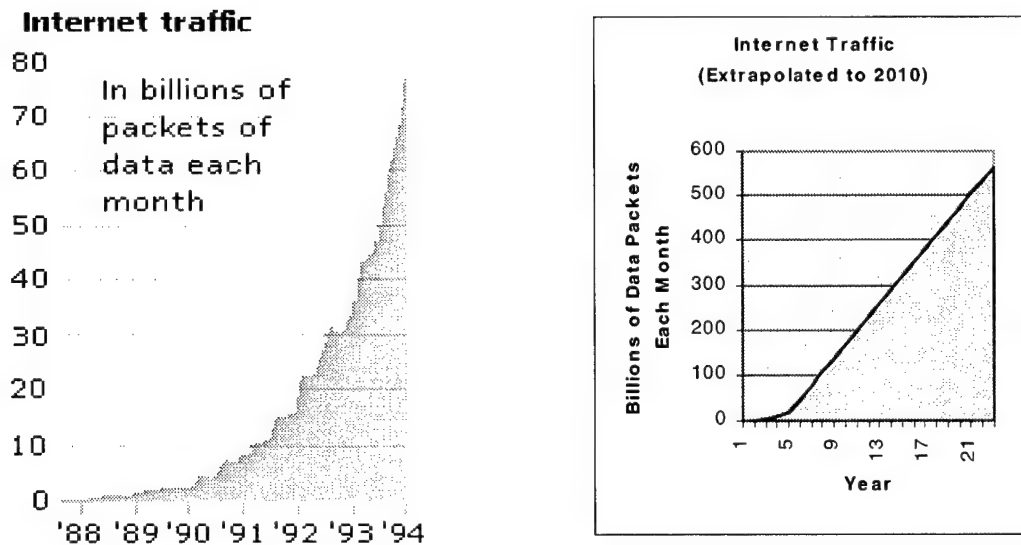
Figure 5. Estimated Growth in Web Users Worldwide



⁹ U.S. Internet Users (1995-2005): www.cyberatlas.com

¹⁰ U.S. Population (1995-2010): www.census.gov

Figure 6. Web Growth Projections¹¹



Note: For the chart on the right, number 1 on the x-axis corresponds to year 1998, number 2 corresponds to year 1999, etc. By 2010, the curve is at the peak of its life cycle and will eventually level off as the market is saturated with Internet connection.

G. Overall Impact of New Technologies

The implementation of the new technologies discussed in this section as well as the implementation of new developments in hardware and software provide an environment that supports business-to-business as well as business to consumer e-commerce. The set of new technologies brings speed and ease to transactions using the Internet. Enhanced speed and efficiency of transactions on the Internet translates into exponential growth in the amount of business conducted through e-commerce. The fact is that use of the Internet is becoming universal, especially in the United States. As more and more of the population is using the Internet at higher and higher transmission speeds, more and more business is being conducted electronically.

The number of Internet users in the U.S. alone is projected to grow from an estimated 36.8 million in 1998 to 66.1 million by 2001. The users of the Internet in the U.S will be 154 million or 82 percent of the working population by 2010. In that year, the working age population, i.e., ages 18 - 65, will be approximately 188 million (Figure 4). Worldwide the number of Internet users has grown rapidly as well. The number of Internet users worldwide stood at approximately 100 million in 1997. That number is projected to reach over 250 million by the end of 2000 (Figure 5).

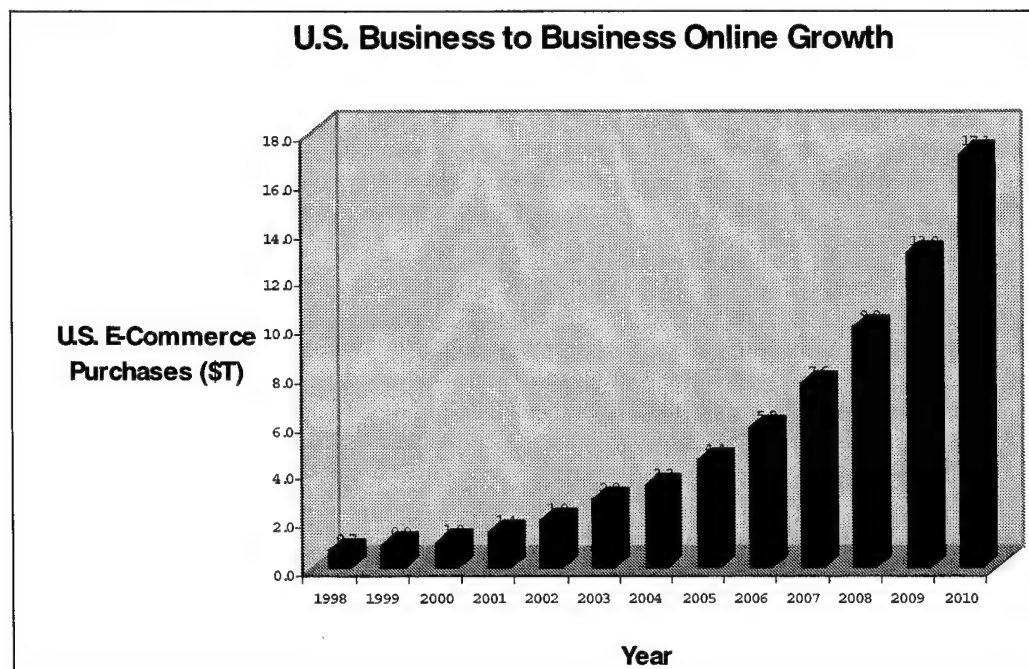
Along with vast increases in the number of Internet users will be vast increases in the amount of Internet traffic. Figure 6 focuses on the growth in the number of packets of data sent each month on the Internet. As shown, the number of billions of packets of data sent each month on the Internet has increased from a level of approximately 30 billion

¹¹ Hoang, Caitlyn, BMGT 798X Working Paper, Smith School of Business

packets a month in 1993 to over 70 billion packets of data per month in 1994. Projecting this growth rate into the future suggests that by the year 2007 there will be 100 billion packets of data sent each month on the Internet.

Business-to-business e-commerce is projected by Forrester Research to reach \$1.4 trillion in annual revenue by 2003, while the business to consumer marketplace is projected to reach a level of \$180 billion in that year (Table 1). As Figure 7 indicates, electronic commerce in the business-to-business space will reach \$17.1 trillion by 2010 based on projections from an exponential growth rate¹². Using time series analysis, e-commerce at the consumer level would be about \$249 billion by 2010. These retail sales would represent approximately 54% of total sales to consumers in 2010 (under the assumption that retail sales continue to grow as they have for the past ten years). Total worldwide e-commerce, including business-to-business transactions, is estimated to be at \$43 billion in 1998 and \$127 billion in 1999. At this growth rate, the total worldwide e-commerce should eclipse \$1 trillion by 2010.¹³

Figure 7. U.S. Business to Business Online Growth



¹² Boston Consulting Group, Lisa Edwards' Paper

¹³ Goldson, Roger, BMGT 798X Working Paper, Smith School of Business

Table 1. The e-Business Marketplace ¹⁴
THE E-BUSINESS MARKETPLACE (in Billions of Dollars)

(Source – Deloitte Research and Forrester Research)

Marketplace	1998	1999	2000 (estimate)	2001 (estimate)	2002 (estimate)	2003 (estimate)
B2B	100	175	300	550	900	1400
B2C	20	40	80	120	150	180

¹⁴ Deloitte Consulting, Online B2B Exchanges: the New Economies of Markets,.

Section 4 Supply Chain Technologies

A. Introduction

Section 1 provided a general overview of new technology developments and their impact on connectivity, hardware, software, system architecture, and artificial intelligence. It concluded with optimistic projections regarding surging e-commerce activity due both to exponential growth in the speed and universality of connections to the Internet and beyond as well as to progress in hardware, software, system architecture, and artificial intelligence.

This section focuses more narrowly on recent and prospective supply chain technological developments. Its initial focus is on developments in the tracking and tracing of supply chain assets and the capturing of this information on a real time basis into supply chain and enterprise resource planning databases. The second focus is the development of middleware to enhance the interoperability of applications among supply chain partners. The third area involves the introduction of software with intelligent alerts based on automated business rules into supply chain applications. The fourth area encompasses the implementation of enterprise information portals with intelligent agents, capable of searching corporate and partner databases and retrieving relevant information on a real time basis. A fifth area involves the increasing reliance on supply exchange portals in which business transactions occur between sellers and buyers. A sixth area involves the field of prognostics—i.e., ability of supply chain assets, like vehicles, to automatically self-diagnose major component systems and provide advance warning of needed replacement parts in order to obtain new parts prior to any service loss.

The third section of this report will focus on how the specific supply chain technologies discussed in this section will be incorporated into an overall set of business practices managing supply chain networks.

B. Real time Asset Tracking and Tracing

Automatic capture systems such as bar code scanning, voice recognition systems, and radio frequency data capture are increasing in popularity among state-of-the-art real time systems. Bar coding is one of the most popular ways to follow the track of products. Yet, there are opportunities to improve bar coding and to make it a more valuable component of the information backbone of supply chain management. For example, increasingly there will be only one bar code label for the entire supply chain. That unique label will stay with each component and product from the supplier to the final user. Today, there are a lot of products not identified with bar code labels and, furthermore, there is incongruence among different labels through the process. Suppliers use one label, then manufacturers take this label out and put on their own. Finally, stores or retail/wholesalers use another different label. A single label for the entire process, enabling data to be shared across the supply chain, would be significantly more efficient than is present practice.

There will be increased demand for more useful information to be included in the bar codes. In response, two-dimensional bar codes and radio frequency identification tags will be developed and popularized in order to have a greater quantity of information about the product included in the bar code. In the near future, voice data collection will increase in popularity allowing workers to catch inventory information while using their hands in other more productive tasks. Hand-free capture systems will dominate the future information collection techniques.¹⁵

Beyond two-dimensional bar codes, the future supply chain organization will use smart bar-code technology that will store information to locate its current position using Global Positioning Satellite (GPS) systems. The smart bar-code will not only include the basic information such as its destination/route, date, weight, or content, but it also stores the last drop and pick-up point as well as a time stamp. It is necessary to have all this information so that when it sends the signal, the GPS system will know exactly what is the current time to calculate how long it will take to arrive at its connecting point or its final destination. So, when customers are trying to locate their parcel online, they will get the real time and precise location of that parcel. When customers are looking at the web browser, they notice the changes in distance traveled as well as the expected time when the good should arrive.¹⁶

Firms must build a messaging backbone and supply chain monitor. Tools from applications suppliers like i2 and Manugistics track inventory and order data through the entire supply chain, allowing IT to tie purchasing and materials management into an established supply chain architecture. Vendors like Descartes will also track operational data across multiple companies, providing an integrated view of this information across a user's supply chain as a service.

To extend the messaging capabilities outside the organization, firms must automate supplier and customer communications and include additional features like security and business process management. Tools from vendors like Extricity and Descartes are still in their infancy but will mature quickly to enable automatic communication with suppliers and customers.¹⁷

Beyond these changes in bar code technology will be the evolution of field equipment and its transformation to interactive and adaptive devices. Today, an I-button device on a crate of milk cartons provides temperature data collected during transportation and transmits it to a reader or scanner once it reaches its destination. In the year 2010, that crate will be shipped in a smart container (i.e., tractor-trailer or a rail car) that would be able to interact in "real time" with the I-button and make any temperature adjustments immediately.¹⁸

¹⁵ Quiros, Fernando, BMGT 798x Working Paper, Smith School of Business

¹⁶ Dinarsakti, Gebyar, BMGT 798X Working Paper, Smith School of Business

¹⁷ Sindwani, Monika, BMGT 798X Working Paper, Smith School of Business

¹⁸ Emberson, Ann, BMGT 798X Working Paper, Smith School of Business

C. Middleware

Middleware is the software "glue" that bonds disparate applications. Middleware technologies such as CORBA or Java RMI have proved their suitability for "standard" client-server applications. However, challenges from existing and new types of applications, including support for multimedia, real time requirements and mobility, seem to indicate the need for defining a new architecture for open distributed systems.

Making such interoperability possible is a short, poorly understood technical specification called Extensible Markup Language (XML). XML describes a class of data objects called "XML documents" that are stored on computers, and it partially describes the behavior of programs that process these objects.

The advantage of XML over its predecessor, Hypertext Markup Language (HTML), is that it enables different computer systems to communicate automatically and handle transactions that otherwise would have required human input. A company could place XML-tagged purchase orders on its Web site. Its suppliers' XML-programmed computers could then download the orders into their own systems, read the orders, and respond with fulfillment automatically. Because of XML tags that identify characteristics of the purchase order, such as price, product model, color, etc., the supplier's XML program could check inventory for those specifics and fulfill the order.

D. Software with Intelligent Alerts Based on Automated Business Rules

An intelligent agent is a notification of events based on customizable, predetermined conditions. Events such as projected inventory problems, resource shortages, and shipping delays are propagated dynamically and based on a set of pre-programmed critical values. Users can drill down from alerts to information required to resolve problems. Alerts can be used to trigger workflow activity. These alerts will not only take place within the organization but also get propagated within the supply chain so that remedial action/ contingency plan could be implemented.¹⁹

Automated inter-business processes will emerge and the process integration between the decision-making systems of businesses, their suppliers, and their customers will become bi-directional and tightly integrated. Suppliers will be able to interact dynamically and initiate business processes within each other's information systems by pre-defining business rules that trigger events across systems. That means that supply chains will be fully automated. For example, when an order comes into a supplier, orders to the supplier's suppliers to replace committed stock are automatically generated and a ripple effect through the supply chain ensues. Less human intervention is required at each step, as inter-business processes become more automated and rules-based.²⁰

¹⁹ Bhargava, Akshaya, BMGT 798X Working Paper, Smith School of Business

²⁰ Sindwani, Monika, BMGT 798X Working Paper, Smith School of Business

E. Enterprise Information Portals with Intelligent Agents

Leading enterprise resource planning (ERP) vendors have given companies an enterprise information portal (EIP), the corporate equivalent of a Web portal such as My Yahoo. An EIP provides a personalized desktop to employees, allowing them to search, retrieve, and organize information from a wide variety of sources to better do their jobs.

Lawson Software will make its LAWSON INSIGHT II SEAport EIP available in June 2000. SAP unveiled its MySAP portal strategy and PeopleSoft unveiled its plans for the PeopleSoft Business Network (PSBN) portal. J. D. Edwards also announced that it's collaborating with IBM on its ActivEra E-Business solutions, which will include the ActivEra Portal, available sometime this fall. EIPs and e-businesses are helping companies use the Internet for strategic advantage, with ubiquitous communication and information sharing.

These portals will become smart enough to act as an agent or a *bot* to search for the specific information an employee needs, extrapolate that information from a variety of structured and unstructured data sources - including the ERP system, data warehouses, legacy systems, and the Internet - and bring it to the user's desktop in a proactive way. The real power is that this approach permits "role-based computing," which represents a fundamental change in how companies feed information to their employees based on their specific roles and functions. An EIP will also have behind it a rich set of document management, knowledge management, and workflow processing systems to automate a corporation's workflow.

'Intelligent Agents' are a network of intelligent software modules that together dynamically manage the supply chain. Each module is an expert at its task, thereby optimizing its goals; coordinates its decisions with other modules, thereby optimizing supply chain wide goals; and quickly responds to changes in cooperation with other modules. All core systems (ERP and others) communicate with each other through these agents using well-understood protocols (XML) in order to facilitate a plug-in/out capability.²¹

F. Development of Supplier Exchange Portals

The business to business e-commerce explosion discussed in the first section on technology developments will be driven by Internet-based trading exchanges. These trading exchanges will be more than portals allowing for real time transactions to occur between buyers and vendors. A complete, Internet-based trading exchange will allow buyers to obtain instant verification of vendor inventories, provide for shipment tracking and tracing in real time, and provide for secure payments as well. These trading exchanges are either private, driven by a single or limited set of buyers linked to a common set of vendors, or public with multiple buyers and vendors.

PlasticsNet.Com was one of the first vertical electronic marketplaces. Founded in 1995 by Chicago-based Commerx, Inc., it boasts more than 90,000 users, including 30,000

²¹ Recharla, Prasad, BMGT 798X Working Paper, Smith School of Business

registered buyers and members. Features of this trading exchange are the ability to compare products and prices across vendors, customize catalogs, streamline and consolidate orders and track the progress of orders online. Other independent trading exchanges that are in various stages of development are CheMatch and ChemConnect in chemicals, SciQuest in life sciences, MetalSite and e-Steel in metals, NetBuy and QuestLink in electronics, and Autovia in the automotive aftermarket.²²

Clearly, these Internet-based trading exchanges will proliferate and drive the growth of business-to-business e-commerce. Furthermore, the exchanges will become increasingly integrated to a firm's overall supply chain strategy. Their real time features for ordering and tracking and tracing as well as their ability to link all parts of an extended enterprise are critical features that will drive supply chain management in the coming decade.

G. Development of Prognostics

The field of prognostics involves the ability of supply chain assets, like vehicles, to automatically and continuously monitor and self-diagnose important component systems. If any system falls below critical performance values, the prognostic system will provide an advance warning with details of the specific parts or components that need to be replaced. The prognostic system is designed to provide early warning of imminent part failure so that replacement parts can be ordered and scheduled for arrival and repair prior to any loss of service due to part failure. Obviously, present preventive maintenance schedules provide for replacement of worn parts prior to their total breakdown. However, the advantage of a prognostic system is that it provides continuous monitoring of major component parts on a real time basis and bases decisions about replacements on actual performance. This contrasts sharply with a scheduled maintenance system that often bases replacement decisions on average performance results, which may vary significantly for each vehicle. A prognostic system will provide a fleet manager with significant reduction in lost time due to parts re-ordering as well as an overall safer level of operations since all of a vehicle's critical systems are monitored on a real time basis.

²² Bowman, Robert, "B2B Commerce Flocks to electronic Trading Exchanges", Global Logistics & Supply Chain Strategies, March 2000.

Section 5 Year 2010 Supply Chain Business Practices

A. Discussion

Regardless of the IT architectures that are employed by the year 2010; or the application-level transport protocols (such as HTTP, FTP, etc.); or the basic message constructs (such as XML headers and MIME types)- the need for underlying business process integration and system documentation of the rules governing that process integration will remain constant. The underlying business processes themselves will likely be transformed and will be radically different from those that dominate industries today.

As massive bandwidth and the multi-media Internet transform the way whole industries conduct business, a fundamentally new set of business/ transaction processes and embedded system process-descriptions/electronic business rules to support those processes will have to be developed. RosettaNet calls these process descriptions “choreographies”.

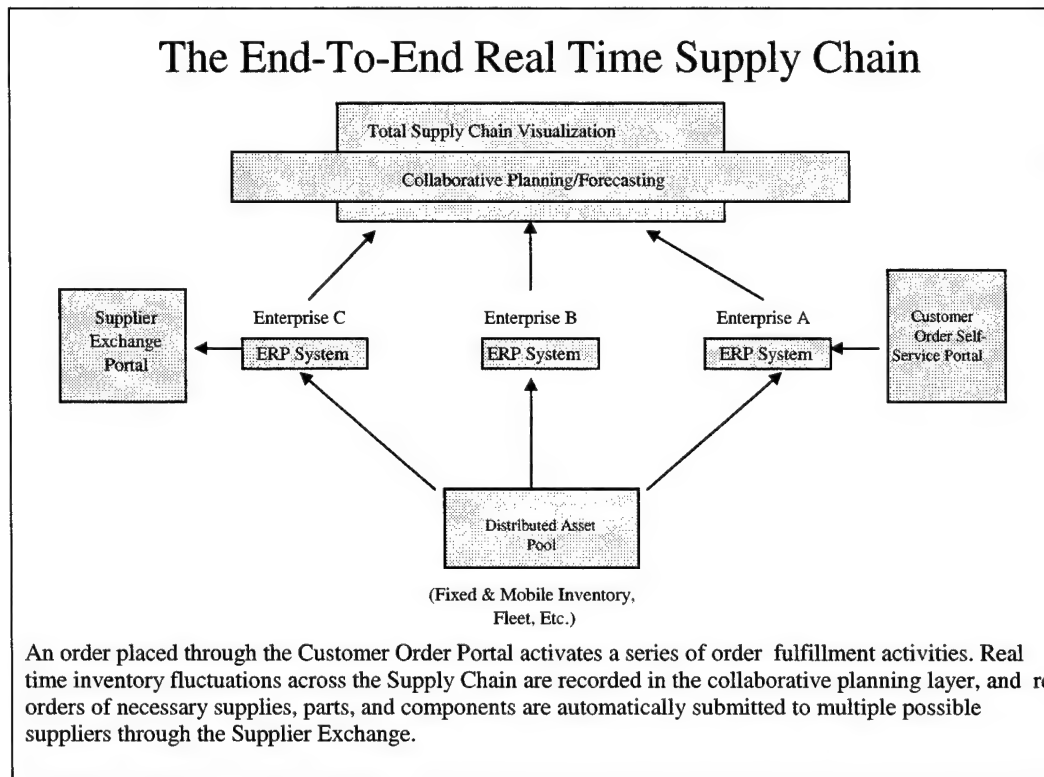
“A simple choreography might be where a message is sent to a server and a response is received. These two messages together form the choreography of the transaction.

The complexity rapidly increases as the choreographies that must be supported increase. The choreographies are often business sector-or application-specific so that only the people who know them well are the business process experts in that application and industry. We see choreographies all the time in information gathering on the Web. More sophisticated transaction choreographies need to be supported, such as those used in Internet credit card purchase transactions, including, for example, issuing the request to buy, verifying the credit card, and confirming the purchase. The shipping facilities are contacted and the product shipped. However, the transaction is not completed until all of the above steps have been completed, perhaps over an extended period of time. One of the most complex choreographies comes from the travel industry, where a single transaction may be composed of airline, car rental, hotel, and other bookings that occur across multiple industries and organizations.²³

When we try to imagine the supply chain business processes and transaction choreographies of the year 2010, we must base the foundation of our scenarios on today’s events and trends. Currently, our definition of real time supply chain processes largely describes a patchwork quilt of technology pieces and programs. This is demonstrated in the figure below (Figure 8), which portrays how companies are cobbling together self-service customer-order portals; ERP systems across internal processes; middleware links to disparate trading partner systems; collaborative planning/forecasting systems to aggregate supply chain community inventory/materials positions and requirements; and purchasing/auction portals to meet those aggregate requirements.

²³ Drummond, Rik, “XML: The Only Chance for A Worldwide Standard”, E-Business Advisor.

Figure 8. The End-to-End Real Time Supply Chain



A key constraint to e-supply chain technology diffusion is the mindset of managers asked to implement these extended enterprise boundary-blurring initiatives. The challenges are unprecedented, including maintaining leadership and “network cohesion” across multiple distributed actors in a global electronic supply chain. To succeed in the deployment of the e-supply chain, e-supply chain managers must be equipped with the ability to lead process re-design groups across traditional organizational boundaries and have the skills to develop incentive/ reward structures that maintain productivity across organizational boundaries. Other important skills and traits that will be required of future e-supply leaders include:

- An orientation towards transactions instead of transformation
- Enable efficient information flow instead controlling information
- Create knowledge teams that are formed and disbanded around real time business needs
- Ability to process, understand, and use a massive volume information faster than ever before

Until today, very few organizations have succeeded in seamlessly integrating all these technology pieces for quantum leaps in business process. The ones that have succeeded are reaping big competitive rewards and offer us a window into netcentric business

processes of the year 2010 supply chain. We shall discuss some of these vanguard organizations and the important insights they provide us into the future

B. Federal Express

Today, Fedex is a leading model of simultaneous processing across an extended supply chain. Federal Express employs real time data transmission to assist in routing and tracking packages. Information recorded by portable bar-code scanners is transmitted to a central database and can be made available to all employees and customers, not just managers in traditional decision-making roles. The FedEx corporate communications network is one of the world's most sophisticated and most reliable, each day processing nearly 400,000 customer-service calls and tracking the location, pickup time, and delivery time of 2.5 million packages.

Federal Express is as much an information firm as a transportation company. Federal Express's business model is now dedicated to:

- increase transaction speed (single transaction triggers multiple enterprise actions)
- connect systems and customers, globally
- reduce costs (shifting processing burden to customers)
- improve information control (available to employees, customers, and between customers)
- provide solutions beyond the immediate business case (through re-engineering the supply chain, and alliance strategies)

The best example of how this is playing out today is the example of Fedex's alliance with Proflowers.com, an internet company that runs a portal for ordering fresh flowers. When Proflowers receives a web order, the Proflower webserver simultaneously records the transaction and messages FEDEX. Based on this message, FEDEX generates both a shipping label (that is returned to the Proflower webserver and downloaded to the grower) and a request to its fleet to pick up the order at the grower's site. When the pickup occurs, the Fedex shipping label with all the requisite customer information is already on the carton of flowers to be shipped.

In essence, Fedex and Proflowers.com are using a single shared trigger event, a customer order on the web, to generate multiple supply chain transactions. This is a completely new paradigm of supply chain, a webbed model (rather than a sequential model based on serial handoffs) to attain quantum leaps in time savings and administrative processing costs.

Thus, the management of information has become one of Fedex's core business assets. The ability to match physical and electronic transactions, to move assets under time-

definite requirements, and superb information control that is transparent to employees and customers are hallmarks of the new business model created by Federal Express.

For the next decade, Fedex has articulated a few major goals as an information company:

FedEx wants to provide "e-care," an optimal experience for its customers. E-care will allow FedEx's customers to provide their own customers with excellent service. With FedEx's systems in place, firms should be able to provide their customers with customized products on a JIT basis, while maintaining minimal inventory.

FedEx wants to develop global information systems for use by customers. The systems will be integrated with customers' systems so that customers will not know where their systems end and FedEx's systems begin. FedEx must meet customers on their own terms, for example, by tracking shipments by *customer* order numbers. FedEx would like to develop an "information superhub". This will allow FedEx to use the information it collects and warehouses in an intelligent manner to foresee industry trends and to provide its customers with useful intelligence

C. SUN Microsystems

The case study on Sun Microsystems, Inc. looks into how net-centric systems will change the shape and culture of supply chain organizations of the future. Sun is the industry leader in scalable servers to power PC Networks and Web sites with \$9.7 billion in revenue, 88% of which is hardware sales. This case focuses on how two of Sun's products, JAVA (a cross-platform programming language) and JINI (software tools that enable devices to plug into and inter-operate via public networks) and similar products from competitors will affect the shape of the company of tomorrow.

In interviews, Sun listed the following three aspects of its business as its major net-centricity vision and initiatives:

Innovation: Sun spends 10.4% of sales on R&D vs. 4.5% at Compaq; its \$400 per employee expenditure is highest in industry.

Demonstration: Sun Peak, a Web-centric infrastructure (servers and Java workstations) links 50,000 employees, suppliers, and distributors. Sun's last mainframe was unplugged in January 1999. The Sun Peak provides the foundation for future growth and flexibility to compete and serves as a demonstration of Sun's role in networking. It will help Sun transform itself to a net-centric way of doing business. The new type of networking will allow Sun to reduce its planning and testing times and costs and move to a collaborative product innovation system based on rapid experimentation and correction off real market/customer data.

Out-Manage The Competition: Sun Peak infrastructure is being used to support a \$250 million supply chain BPR project designed to cut 5 weeks out of 14 week product cycle times and 25% of cost. This reengineering of the supply chain is vital, given the speed and volatility of the high tech marketplace.

The current management challenges Sun is grappling with are many. First, it must master better surge management techniques to cope with volatility in the marketplace, with 480% spikes in demand for a product in one year. The motto for this is: "Better to be flexible than right." **It cannot simply be better at forecasting; the Sun supply chain must be better at adapting to real time demands on a chain-wide basis. One way to do this is via a shared extended enterprise-wide data network and more collaborative relationships across the chain that exploit this available real time data.**

Another way to do this is to implement Jini-enabled supply chains that automatically adjust networked assets, machines, and inventories to real demand. Once plugged into a network, a Jini-enabled device, which has an address, can broadcast its capabilities to other devices in the network. With Jini-enabled devices, shared power, shared knowledge, equal access, expandability, and adaptability are possible. An important characteristic of Jini is its ability to work over existing networking software and protocols. So far, companies such as Canon, Epson, Ericsson, Mitsubishi, Quantum, Seagate, Sony, and Toshiba are onboard with Jini.

Internally, Sun is attempting to use Jini to implement a "Virtual Merge" functionality in the supply chain, or a real time synchronization of all components to arrive into production/distribution staging areas at same time.

Other current management challenges include implementing horizontal process owners/incentives and spiral promotion policies so that workforce development and deployment can keep pace with the netcentric technology infrastructure being developed.

A final challenge is development of a single HTML-based control panel/ and displays for all supply chain data so process owners have comprehensive chain-wide visualization capabilities.

D. Cisco

Cisco Systems has tripled in market value just in the past year to surpass Microsoft and to become the world's most valuable company. This valuation reflects not only the quality of its router products; not only the dynamism of its core market with Internet traffic doubling every three months, but also its profound mastery of supply chain and e-business processes utilizing the Internet.

Cisco has employed the Internet to reengineer processes across its whole span of operations and has become a global networked organization. Every step of its supply chain, from customer order self-service/ product configuration to supplier management, employs Internet-based processes. This has worked so well that Cisco's per employee revenue is almost three times that of competitors such as Lucent. Cisco has reaped huge benefits from successfully and seamlessly integrating the fundamental technologies and components of the Internet on an enterprise-wide basis. This pervasiveness of Internet processes and associated benefits realized are shown below:

APPLICATION	WHAT HAPPENS?	BENEFITS
Technical Self-Help	Customers submit support requests and find answers to frequently asked questions on the Cisco Web site. In addition, they can download software updates and diagnostic tools, get help in an electronic forum, communicate electronically with support staff and register to receive automatic notification of software bugs and updates.	<p>Cisco has been able to grow its business and improve the quality of technical support while reducing support costs. With immediate access to a variety of support information and tools customers can choose what they need. Customer support representatives can focus more time on the most challenging problems.</p> <p>*ROI: By not having to hire and train engineers to provide technical support (including diagnostic tools and an open forum where other customers respond to queries), Cisco saves \$75 million annually. Providing the same access for non-technical support saves \$8 million.</p>
Electronic Commerce	Customers can use a Web-based application to price, configure, validate, and order products. They can also use it to get copies of invoices, review shipping schedules, and receive notifications of shipments or changes. The application is linked to centralized internal systems that share new product information and engineering change orders with various satellite applications to coordinate the entire supply chain.	<p>Cisco has been able to lower the overall cost of taking orders and also reduce errors in product configuration and ordering—thus reducing the expenses as well as the customer frustrations associated with product returns caused by configuration errors. Cisco customers report that their own purchasing productivity has increased because they have 24-hour access to an easy-to-use, self-service system.</p> <p>* ROI: By automatically tapping errors at the configuration stage, Cisco has reduced, from 15 percent to 2 percent, the orders that require re- working. With the increased accuracy in ordering, product delivery lead times have been reduced by 2-5 days. And Cisco's sales personnel, now freed from most order-related administrative tasks, can concentrate on proactive account management.</p>
Software Distribution	Software, including upgrades and beta versions of new releases is available via Cisco's Web site. A feedback form encourages comments from users.	<p>Cisco saves the cost of software distribution, customers have immediate access to new versions and upgrades. Cisco also gets valuable customer feedback on prereleased software.</p> <p>*ROI: By distributing 90 percent of its software and documentation electronically, Cisco saves \$250 million annually in printing and shipping costs.</p>
Expense Reporting	Employees file expense reports electronically, using a Web-based application that is linked to internal finance and human resource systems, checks submissions immediately, flagging policy violations and paying approved expenses within four days. Cisco pays American Express directly, on the employees' behalf, for AmEx charges assigned to the expense reports. Only exceptions are handled outside the automatic system.	<p>Cisco reduces the cost of managing expense reports. Employee satisfaction is higher because of the fast turnaround, and employee productivity is higher because expense reporting now takes less time. And, because fewer reports are late, Cisco can track expenses more closely.</p> <p>*ROL: By using this Web-based system that requires only two auditors for 12,000 employees, Cisco saves the cost of the 10 additional people typically dedicated to auditing expense reports in a company of its size.</p>
Supply-Chain Management	Cisco's electronic commerce application Automatically notifies a group of suppliers When incoming orders deviate from forecasts.	<p>Cisco has been able to increase responsiveness to customer requests while lowering inventory costs and reducing product delivery lead times. Cisco has also been able to improve its inventory tracking and to respond more quickly to component shortages by transferring inventory between different suppliers.</p> <p>*ROI: By increasing responsiveness to customers, Cisco has been able to improve revenue capture by \$100 million annually. By integrating suppliers earlier in the ordering process, the company has reduced lead times—from an average of 40 days to 7-21. Cisco's supply chain initiatives save over \$70 million annually.</p>

E. The Automotive Network Exchange

The Automotive Network Exchange (ANX) highlights how networks are changing the way companies interact with each other not only across supply chains, but across whole industries.

As an industry-wide real time management infrastructure, this virtual private network provides the medium for e-commerce and data transfer among authorized automotive trading partners. ANX provides a common transaction infrastructure to handle computer-aided design (CAD) files, purchase orders, and payments in North America.

ANX is the product of an industry-sponsored initiative led by Ford, Chrysler, and General Motors, working in concert with the AIAG (Auto Industry Association Group) and nearly 3 dozen automotive trading partners. Participants in the ANX project identified four criteria that they felt were essential for their communications: security, management, reliability, and performance. As is well known, the issues of reliability (servers that are down) – and performance (fluctuating transfer rates) are current serious concerns for users of the public Internet.

ANX was designed to be as secure as a Virtual Private Network (VPN); have an organization responsible for managing the transport of the electronic data (the ANX Overseer); and have a reliable infrastructure and a steady performance.

F. ANX Design Issues And Solutions

ANX Performance. A stable level of performance is a key advantage of ANX over the public Internet today, because transmission rates fluctuate in the public Internet. Highly synchronized production facilities require real time data transmission, which can only be achieved with a network that offers a predictable performance. Organizations are asking for performance guarantees, like those that the telephone companies routinely provide. The issue of data transmission performance is crucial for manufacturing companies that work in a Just-in-Time environment, where electronic data runs parallel to the physical transport of goods. A company that connects to the ANX service may choose between different performance or bandwidth levels, starting from a 52 KBPS dial-up line up to a 3 MBPS dedicated line or more.

ANX Reliability. Common problems for users of the public Internet are data loss or servers that are not accessible. Within the ANX community, “certified” Internet Service Providers – the CSPs – are committed to guarantee a very high level of availability of their infrastructure and, thus, a high reliability. They take the full responsibility for the data transport from one trading partner through the ANX “cloud” over to the other trading partner. Thus, trading partners do not need to worry about losing data as is happening on the public Internet.

ANX Security. ANX has addressed this problem with the adoption of the Internet Protocol Security (IPS) standard. Within the ANX cloud, CSPs are allowed to exchange data only with other certified CSPs. This ensures that no data is sent “unattended” over the public infrastructure.

ANX Management. Whereas there is no central management of the public Internet, the management of VPNs is limited to a service provider's customers. This means that there is no single organization responsible for the management of data that runs across the secure VPNs.

Within the ANX community, the ANX Overseer (Bellcore) is the entity responsible for managing data that runs among the certified Internet Service Providers. The ANXO additionally provides information to the trading partners about the performance and availability of ANX services. According to Forrester Research, "corporate extranets need a single-point management solution for all security options." This issue has been addressed by ANX through the ANXO function. Additionally to these advantages, AIAG members argue that the service quality of the CSPs will be improved over time due to competition for the acquisition of trading partners.

Anticipated Impacts of ANX Between Business Partners. Direct cost savings include: *cost reductions* through elimination of contract, billing, network management, equipment maintenance, and floor space overhead, through elimination of transaction-based charges for connectivity, through elimination of private lines; and *complexity reduction* through reduced need for multiple providers to reach trading partners globally, and through increased compatibility. **ANX is expected to reduce purchasing cycle times by a factor of four, thereby saving the industry \$1 billion/year in information processing costs.**

An earlier study of AIAG found out that with better electronic data transfer infrastructure across the supply chain the communication from OEM to lower tier levels could be reduced from 4 down to 1 week. This reduction would save approximately 70 dollars per car and total annual savings in the automotive industry of about \$1.1 billion. They further stated that the biggest savings could be achieved among the suppliers themselves, since 60% of the cost of a vehicle is generated within the supply chain.

Indirect savings can be achieved through the ability to carry out business strategy more effectively by deploying electronic processes over ANX, through the ability to serve more customers more quickly and efficiently, through improved business relationships, and through the possibility to run bids over the TCP/IP platform.

AIAG members predict a payback period for ANX of less than half a year for large and medium trading partners, and less than a year and a half for small firms, based on the direct cost reductions achieved through savings in connectivity costs.

In conclusion, the ANX business model is a good example of the direction industry-wide business to business network relationships must take to be successful in the future. As influential and important as the public Internet has been in the last five years in shaping how companies send information to each other, there are still major shortcomings in the system. The ANX model highlights these problems and shows a way of tackling them.

A major hurdle in using the Internet for business to business communications was the lack of accountability in the system. If a message did not make it to the intended recipient, there was no one to be held responsible for the error. The ANX system solves

this problem with the addition of the ANXO. Overcoming such obstacles in the diffusion of networking systems will help alleviate the fears of management and increase the number of companies who are willing to take part in the venture.

G. Conclusions: Major Business Process Themes For The Year 2010 Supply Chain

The review of the pioneering organizations described above give us insights into the possible direction and character of business processes in the year 2010 supply chain.

The major inter-related themes that emerge are the following:

1. Supply chain business processes will capitalize on massive available bandwidth through simultaneous, rather than serial processing, e.g., a single event will trigger multiple real time actions throughout the chain. As shown in the Fedex case, this will overturn our highly linear paradigm of supply chain operations and lead to a new webbed model.
2. More seamless technology integration across supply chain activities will enable the “straight through processing” of customer orders. Customer self service portals will increasingly set the pace for the whole supply chain and provide clear real time market feedback and strongly signal inventory requirements directly to the supply base. This will have tremendous implications in cutting the costs generated by chain-wide buffer-stocking as hedges against unknown demand patterns, a syndrome known as the bullwhip effect. This is the implication of the Cisco case.
3. Real time extended enterprise architectures will not only permit new transaction efficiencies between trading partners, but also new strategy and product planning efficiencies, as the case of Sun implied. This is a very important distinction-not only the process but the product itself, it’s very design and evolving menu of features- will align with customer requirements more in real time.
4. Increasingly, the emphasis in business process design and performance effectiveness will move from an emphasis on the individual organization and its supply chain, to industry-wide process design and effectiveness. This is the implication of the ANX case.

Section 6 Conclusion and Recommendations

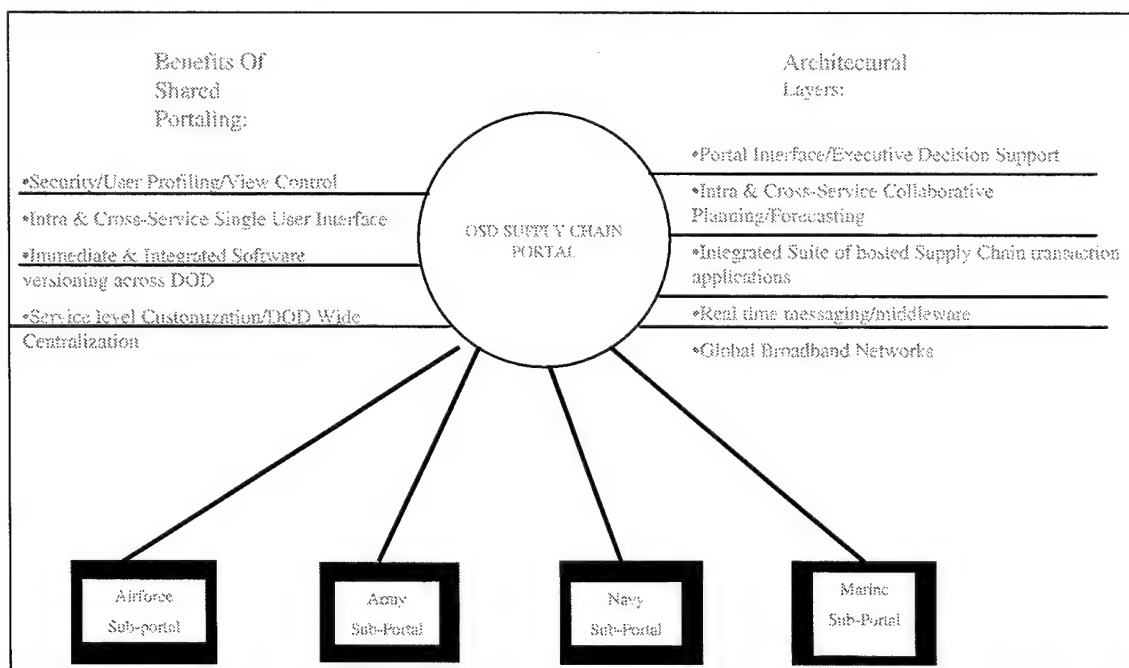
DOD supply chain planners need a middleware and real time messaging system. OSD must establish a shared supply chain ASP capability to support joint forces efficiently, distribute technology upgrades instantly, and support DOD wide deployment visibility.

DOD should expand discussion with global telecommunications companies and ASPs to ensure availability of hosted supply chain suites

DOD must pursue a centralized portal and hosting strategy for supply chain suites, whether portal management and hosting is done internally on DOD networks or externally on Telco/ASP networks While actively pursuing supply management/procurement portals, DOD must monitor the negative impact of such activities on core suppliers(i.e., squeeze on quality and economic viability).

DOD must focus on a massive diffusion strategy, involving pervasive portable Internet devices, wireless Internet access, and terrestrial/satellite infrastructure.

Figure 9. "Architech-ing" a Logistics Framework for the Year 2010



Appendix B

Logistics Initiatives by Organization and Submitted Document

Tables B-1 through B-6 comprise the master list of logistics initiatives from the Best Commercial Practices 1999 Report to Congress, POM Tabs N-4s and Gs, and the DRID 54 responses. There is one table for each of the Services, USTRANSCOM, and the DLA. Each table contains a complete list of initiatives, listed alphabetically, with the source(s) indicated by an "X" in the appropriate column(s). These tables reflect the starting point for our analysis of DoD's logistics technology plans.

Table B-1. Army Logistics Initiatives

Initiative	Report to Congress	POM Tab N	POM Tab G	DRID 54
Abrams M-1 tank ^a		X		
Advanced field artillery tactical data system ^a		X		
Air load module			X	
Analysis and studies of future logistics requirements				X
Apache AH-64 ^a	X	X		
Army in-transit visibility		X		X
Army logistics over the shore (LOTS) and watercraft				X
Army prepositioned stocks/ashore/afloat				X
Army strategic mobility plan				X
Automatic identification technology			X	X
Built-in prognostics and diagnostics				X
Chinook CH-47 ^a		X		
Class I configured loads				X
Comanche RAH-66 ^a		X		
Commodity command standard system			X	
Consolidated contractor life cycle support—training aids and simulators	X	X		
Crusader ^a		X		
Deployment automation				X
Deployment outloading				X
Deployment stock package				X
Depot repair process improvements	X	X		
Distribution-based logistics system				X
Department of the Army (DoA) movement management system			X	

Table B-1. Army Logistics Initiatives (Continued)

Initiative	Report to Congress	POM Tab N	POM Tab G	DRID 54
Electronic sustainment support centers	X	X		
Electronic technical manuals and equipment downtime analyzer		X		X
Focused sustainment	X			
Global combat support system	X	X		X
Heavy expanded mobility tactical trucks ^a		X		
High mobility artillery rocket system ^a		X		
Implement customer wait time (CWT)		X		X
Implement dollar-cost branding		X		X
Implement forward stock positioning				X
Implement national maintenance program	X	X		X
Implement TAV	X	X		X
Implement Web-based logistics				X
Integrated logistics analyzer program		X		X
Integrated sustainment maintenance (ISM)	X			
Interactive electronic technical manuals				X
Joint computer aided acquisition and logistics support (JCALS)			X	X
JP8 vs. Jet A-1 study				X
Lateral redistribution	X	X		X
Lead-time reduction	X	X		
Logistics integrated database	X	X		
Logistics supply systems			X	
M109 family of vehicles fleet management (recommended for termination)	X	X		
Material management system implementation			X	
Mission-configured loads				X
Modernization through spares	X	X		
Modernize Army tool kits		X		X
Recapitalization of aging equipment to ensure operational effectiveness				X
Reduce repair cycle time				X
Reduce support requirements through science and technology				X
Revised readiness report				X
Secure tactical local area network (LAN)				X
Simplified priority system		X		X
Single stock fund	X	X		X
Supply management, Army-operations and support cost reduction (SMA-OSCR)		X		
Standard Army Ammunition System			X	
Standard Army Depot System			X	
Standard Army Maintenance System			X	
Standard Army Retail Supply System			X	
Standard retail supply system interface—paperless contracting	X	X		

Table B-1. Army Logistics Initiatives (Continued)

Initiative	Report to Congress	POM Tab N	POM Tab G	DRID 54
Strategic configured loads and strategic logistics program			X	
Total distribution program			X	
Total ownership costs				X
Transportation coordination automated information system			X	
Unit-level logistics system			X	
Velocity management	X	X		X
Virtual integrated materiel management center	X	X		
Wholesale logistics modernization program	X	X	X	

^a Denotes a product support pilot program.

Table B-2. Navy Logistics Initiatives

Initiative	Report to Congress	POM Tab N	POM Tab G	DRID 54
Affordability through commonality program effort—Naval Sea Systems Command (NAVSEA)				X
Automatic identification technology			X	
Aviation maintenance and supply readiness—Naval Air Systems Command (NAVAIR)				X
Baseline advanced industrial management			X	
Collaboration-at-sea initiative				X
Competency management program (NAVSEA)				X
Contractor logistics support	X	X		
Cost reduction through standardization—Military Sealift Command (MSC)				X
Customer wait time	X	X		
Depot maintenance system			X	
Design for ownership (NAVSEA)				X
Direct vendor delivery	X			
Distribution standard system			X	
Distance support/anchor desk/integrated call center (NAVSEA)				X
Electronic Servmart shopping	X	X		
Enable condition-based maintenance—Office of Naval Research (ONR)				X
Enhanced sparing model	X	X		
Enterprise resource planning (ERP)	X	X	X	X
Establish a system that provides each military sealift command ship total asset visibility (MSC)				X
Finance an air clearance transportation system			X	
Fleet support team (FST) (NAVAIR)				X
H-60 helicopter ^a		X		
Independent logistics assessment certification (NAVSEA)				X
Integrated product support (NAVSEA)				X

Table B-2. Navy Logistics Initiatives (Continued)

Initiative	Report to Congress	POM Tab N	POM Tab G	DRID 54
Inventory control points—uniform automated data processing			X	
Joint aviation technical data integration (NAVAIR)				X
Joint computer-aided acquisition and logistics system			X	
Joint engineer data management information control system			X	
Logistics e-business concept of operations (NAVSEA)				X
Logistics engineering change proposal program—Naval Supply Systems Command (NAVSUP)	X	X		X
Long-term contracting	X	X		
Maintenance cycle time reengineering	X	X		
Manufacturing resource planning II	X	X		
Material management system implementation			X	
Material requirements review—response times and efficiency of fleet issue load lists	X	X		
Metrology automated system uniform recalibration/reporting			X	
Modernization of maintenance information support systems	X	X		
Manufacturing resources planning (MRPII)			X	
NAVAIR depot workload control system			X	
NAVAIR logistics data analysis			X	
NAVAIR plan for total asset visibility for sponsor-owned material		X		X
Naval industrial material management system			X	
Naval ordnance joint total asset visibility—Chief of Naval Operations-Logistics (CNO N4)				X
Naval ordnance readiness improvement process				X
NAVSEA data environment				X
NAVSEA depot maintenance system			X	
Navy and Marine Corps intranet				X
Navy electronic commerce online	X	X		
Navy tactical communication support system			X	
One-touch support initiative (NAVSUP)	X	X		X
Organic industrial enterprise logistics support—Naval Inventory Control Point (NAVICP) broad agency announcement (BAA)	X	X		
Plan to fully implement total asset visibility (NAVSUP)		X		X
Plan to implement CWT (NAVSUP)		X		X
Professional development program (NAVAIR)				X
Quality management system (NAVAIR)				X
Rapid retargeting	X	X		
Readiness support systems	X	X		
Reduce CWT for military sealift command ship material				X
Reduce overall costs to customer (MSC)				X
Re-engineer applicable naval ordnance logistic processes/systems (CNO N4)				X
Regional maintenance automated information system			X	

Table B-2. Navy Logistics Initiatives (Continued)

Initiative	Report to Congress	POM Tab N	POM Tab G	DRID 54
Regional third-party logistics providers	X	X		
Response to failure (NAVAIR)				X
Retention level review	X	X		
Serial number tracking	X			
Serial number tracking (NAVAIR)		X		X
Ship configuration and logistics support information system			X	
Stock points—uniform automated data processing			X	
Support equipment resource management information system			X	
Sustained maintenance planning (NAVAIR)				X
Technical publications life-cycle processes (NAVAIR)				X
Third-party logistics providers—retrograde management	X	X		
Total ownership cost reduction (NAVSEA)				X
Toolbox (NAVAIR)				X
Top management attention/top management issues				X
Total asset visibility—Navy	X			
Total asset visibility (NAVSEA)			X	
Total ownership cost (NAVAIR)				X
Transportation coordination automated information system			X	
Trident logistics data system			X	
Update and revise military sealift command logistics systems and procedures (MSC)				X
Warfighter—increase readiness, effectiveness and satisfaction through use of performance metrics (NAVAIR)				X

^a Denotes a product support pilot program.

Table B-3. Marine Corps Logistics Initiatives

Initiative	Report to Congress	POM Tab N	POM Tab G	DRID 54
Asset tracking logistics and support system			X	
Atlass II		X		
Contractor logistics support	X			X
Creation of product management teams				X
Develop mean time between failures (MTBF) as effective readiness indicator				X
Establishment and maturation of Marine Corps Material Command (MARCORMATCOM)				X
Future MARCORMATCOM organizational adjustments and considerations				X
Given total ownership cost (TOC) methodology, identify steps to reduce TOC				X
Identify TOC methodology and obtain necessary data to compute TOC				X

Table B-3. Marine Corps Logistics Initiatives (Continued)

Initiative	Report to Congress	POM Tab N	POM Tab G	DRID 54
Integrated logistics capability (ILC)		X		
Implement customer wait time				X
Implement total asset visibility	X			X
Improve management of secondary reparable				X
Infrastructure improvement to improve strategic mobility				X
Joint services/agency interaction and coordination				X
Major task force war planning module II			X	
MARCORMATCOM strategic business plan				X
Marine Corps logistics campaign plan				X
Minimize logistics costs while meeting warfighter requirements				X
Mobility requirements study (MRS-05)				X
Prime vendor—United States Marine Corps	X			
Protection of movement information in defense transportation system automated information systems				X
Purchase Blount Island				X
Re-engineer/modernize applicable logistics processes/systems				X
Simplification of processes required to get equipment to the warfighter				X
Small-unit logistics		X		
Strategic airlift in the Western Pacific (WESTPAC)				X

Table B-4. Air Force Logistics Initiatives

Initiative	Report to Congress	POM Tab N	POM Tab G	DRID 54
Acquisition lead time reduction through long-term contracts with vendors		X		
Air Force performance measure reporting system				X
Aircraft repair enhancement program	X			
Aircraft spares availability				X
Asset management improvements through integrated information systems and Web enabled consumables management				X
Cargo movement operational system			X	
Combat ammunition system			X	
Comprehensive engine management system			X	
Contract depot maintenance activity group (DMAG) management		X		
Contract repair enhancement program	X			
Core automated maintenance system			X	
Corporate contracts—increase use to minimize cost	X			
Cost savings modernization initiative		X		X
Data integration and warehousing				X

Table B-4. Air Force Logistics Initiatives (Continued)

Initiative	Report to Congress	POM Tab N	POM Tab G	DRID 54
Depot maintenance consolidation	X	X		
Depot repair enhancement program	X			
Execution and prioritization of repair support system	X			
Exploitation of AIT				X
Express transportation	X			
Fuels automated system			X	
Global Command and Control System (GCCS)				X
Implement CWT				X
Implement total asset visibility				X
Industrial engineer technical programs		X		
Infrastructure improvements at Air Force Material Command (AFMC) installations		X		
Integrated information systems				X
Integrated logistics system—supply	X		X	
Integrated maintenance data systems	X		X	
Joint ammunition management system			X	
Joint logistics systems center		X		
Logistics transformation scorecard				X
Logistics transformation and functional integration	X			
Maintenance planning and execution system			X	
Material/parts ordering process automation		X		
Merge flightline and depot systems				X
Merger of D041 and D062 systems	X			
Merlin 2000				X
Network optimization				X
Online vehicle interactive management system			X	
Pipeline tracking analysis and metrics system	X		X	
Product support partnerships				X
Propulsion acquisition lead time		X		
Public/private competition		X		
Reengineered logistics support concepts				X
Reengineering supply support process	X			
Reengineering templates		X		
Regional supply squadron	X			
Reliability and maintenance information system			X	
Requirements data bank			X	
Requirements management system	X			
Standard base supply system			X	
Stock control system			X	
Supply and transportation unit reengineering	X			
Supply chain management				X

Table B-4. Air Force Logistics Initiatives (Continued)

Initiative	Report to Congress	POM Tab N	POM Tab G	DRID 54
Support expeditionary aerospace force	X	X		
System executive management report				X
Transportation coordination automated information system II			X	
Virtual prime vendor				
Weapon systems—establish technically compliant operations across all product lines		X		
Weapons systems management information system			X	
Web enablement				X
Web-enabled consumables management				X
Workforce—develop qualified AFMC depot staff		X		
Workload consolidation		X		

Table B-5. DLA Logistics Initiatives

Initiative	Report to Congress	POM Tab N	POM Tab G	DRID 54
Advanced shipping notification system			X	
Catalog re-engineering system			X	
Defense Depot San Joaquin (DDJC) distribution center 2000		X		
Defense Distribution Depot Susquehanna (DDSP) distribution center 2001		X		
DDSP electronic document management control		X		
Defense fuel automated system			X	
Defense integrated subsistence management system			X	
Defense property accountability system			X	
Defense reutilization and marketing system			X	
Distribution standard system			X	
DLA business reengineering			X	
DLA business system modernization			X	
Federal logistics information system			X	
Forward stocking policy		X		
Fuels automated system			X	
Implement customer wait time				X
Improve strategic mobility				X
Joint total asset visibility system			X	
Logistics community management			X	
Minimize logistics costs while meeting warfighter requirements				X
Optimize support to the warfighter				X
Reengineer/modernize applicable logistics processes/systems				X
Standard Automated Material Management System (SAMMS)			X	
Subsistence total order and receipt electronic system			X	

Table B-6. USTRANSCOM Logistics Initiatives

Initiative	Report to Congress	POM Tab N	POM Tab G	DRID 54
Accommodating surge shipping requirements				X
Advanced shipping notices			X	
Automated identification technology/total asset visibility				X
Automated information technologies			X	
Automated system for transportation data			X	
Avoidance of material cost		X		
C-17 combustion engine exit temperature kit		X		
C-5 anti-skid upgrade		X		
C-5 fuel flow indicator/transmitter		X		
C-5 high-pressure turbine upgrade		X		
CONUS freight management system			X	
Core automated maintenance system			X	
Crowley containership contract		X		
Defense Transportation System command and control (DTS C2)				X
DTS Enterprise Architecture				X
DTS migration				X
DTS scheduling				X
Global air traffic management (GATM)				X
Greater use of modeling and simulation				X
Heavy Lift Propositioning Ships (HLPS) II contract		X		
Improve sealift capability				X
Improve transportation infrastructure				X
Improve transportation cost estimates				X
Increase airlift capacity				X
Increase airlift reliability				X
Increase customer service				X
Integrated command, control, and communication system			X	
Interim teleport				X
In-transit visibility			X	
Joint logistics over the shore (JLOTS)				X
Joint Operation Planning and Execution System (JOPES)				X
Large Aircraft Infrared Countermeasures (LAIRCM)				X
Material Handling Equipment (MHE)				X
Selection of intermodal shipping providers				X
Strategic Distribution Management Initiative (SDMI)				X
TDD				X
Transportation business decision support system			X	
Transportation Financial Management System (TFMS)				X
Transportation operational person property system			X	
US flag sealift				X
Worldwide port system			X	

Appendix C

Abbreviations

3PL	third-party logistics
ACTD	Advanced Concept Technology Demonstration
ADUSD	Assistant Deputy Under Secretary of Defense
AIT	automatic identification technology
ALP	Advanced Logistics Program
ASP	application service provider
BDSS	Business Decision Support System
C3I	Command, Control, Communications and Intelligence
CEDI	commercial electronic data interchange
COE	common operating environment
CONUS	continental United States
COTS	commercial off-the-shelf
Cougaar	cognitive agent architecture
CWT	customer wait time
DARPA	Defense Advanced Research Projects Agency
DISA	Defense Information Systems Agency
DLA	Defense Logistics Agency
DoD	Department of Defense
DRID	Defense Reform Initiative Directive
DTS	Defense Transportation System
DTTS	Defense Transportation Tracking System

DVD	direct vendor delivery
EIP	enterprise information portal
ERP	enterprise resources planning
GPS	global positioning system
GTN	Global Transportation Network
GTV	global in-transit visibility
HHT	hand-held terminal
IAs	intelligent agent
IPS	Internet Protocol Security
IRAM	intelligent random-access memory
JSF	Joint Strike Fighter
JTAV	joint total asset visibility
LA	Logistics Architecture
LMI	Logistics Management Institute
MC	mission-capable
MRPII	manufacturing resources planning
OMFTS	operational maneuver from the sea
OSD	Office of the Secretary of Defense
POM	Program Objective Memorandum
PV	prime vendor
RF	radio-frequency
RFID	radio-frequency identification
SDMI	Strategic Distribution Management Initiative
TAV	total asset visibility
TDD	time-definite delivery

TOC	total ownership cost
USTRANSCOM	U.S. Transportation Command
VPV	virtual prime vendor
XML	Extensible Markup Language

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